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POWER FOR INTERURBAN RAILROAD

Electricity Developed by Steam Turbines at Fraser, Ia., Runs Trains, Operates Mines and Drives Industrial Plants at Great Distances

HARDLY MORE THAN 2 generations ago, the only paths through the woods and along the valley of the Des Moines River were those made by Indians, and to follow them was slow and laborious work. Recently a Practical Engineer scribe was taken whizzing up this valley, through the woods and over the ravines leading to the river, and enjoyed every foot of the trip. There were the thrills of mountain travel, the rapidity of the fastest trains, the freshness of ocean air and scenery rivaled only by such rivers as the Hudson.

From the Indian trail to the electric train in 50 yr. is a great advance and has been possible only in sections of the country where natural conditions were ripe for rapid development and improvements. Iowa is primarily an agricultural state, vast tracts of land requiring nothing more than the plow to put them into condition to serve man, yet with large coal fields and gypsum quarries manufacturing industries are rapidly increasing throughout the state.

Under such conditions, one would naturally expect an interurban railway to prosper and grow to such an extent that the demands for power continually keep crowding the power plant. This has been the case with the Central Iowa Light & Power Co., which furnishes electric power to operate the trains of the Ft. Dodge, Des Moines & Southern Railroad Co., as well as electricity for mines, gypsum mills and several cities and towns.

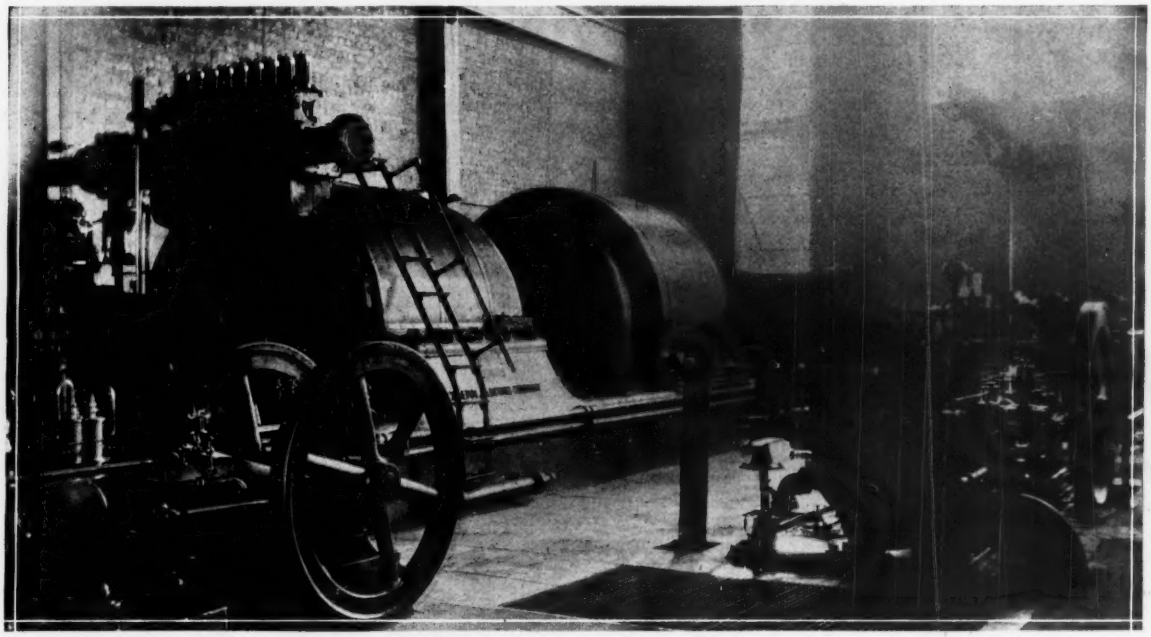


FIG. 2. RECENTLY INSTALLED TURBINE UNIT AND VACUUM PUMP

As formerly equipped, the plant at Fraser had a capacity of 2500 kw., but during the past year a new turbine of 4000 kw. has been put into operation. While we are particularly interested in the new equipment,

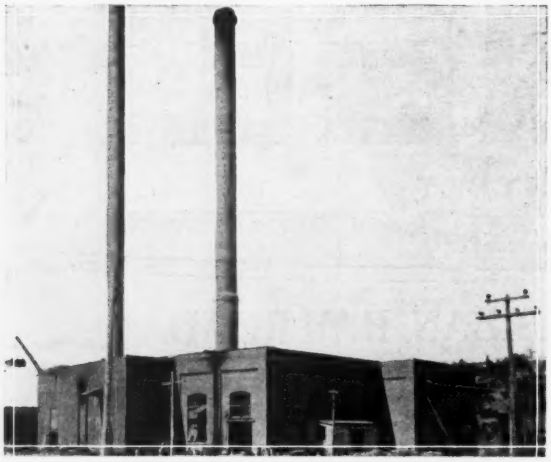


FIG. 1. CENTRAL IOWA LIGHT & POWER CO. PLANT AT FRASER

there are a number of features of considerable value in the old arrangement, and to do the plant justice, a description of the entire generating system is necessary.

makes possible the generation of electric energy at a comparatively low cost, so low, in fact, that it can be transmitted many miles, and sold at a reasonable profit to the company.

Hauled to the power house in the company's own cars, the coal is unloaded by a locomotive crane into a Jeffrey coal crusher, after which it is delivered to bunkers over the boilers, to which it is fed through chutes in each of which are placed scales for weighing the amount used by each boiler.

In all, there are 5 boilers, 3 Aultman & Taylor water-tube boilers rated at 500 hp. each, the other 2 Edge Moor boilers, one 500 and the other 600 hp. All of these boilers are equipped with Green chain grates operated from a line shaft above the hoppers, which is driven either by a Wachs engine or a motor, as occasion requires.

Foster superheaters have been placed in the last pass of each boiler, giving the steam at 175 lb. pressure 125 deg. superheat, this practice proving very satisfactory in operation, inasmuch as the boilers are heavily loaded and turbines are found to operate most economically with superheated steam.

Further equipment of the boilers is standard with the exception of a Vulcan soot blower placed on each boiler.

As will be noted in Fig. 1, there are 2 stacks, each 185 ft. in height; one of reinforced concrete, made by Custodis of New York, is 6 ft. inside diameter, while the other is of steel, 3½ ft. in diameter.

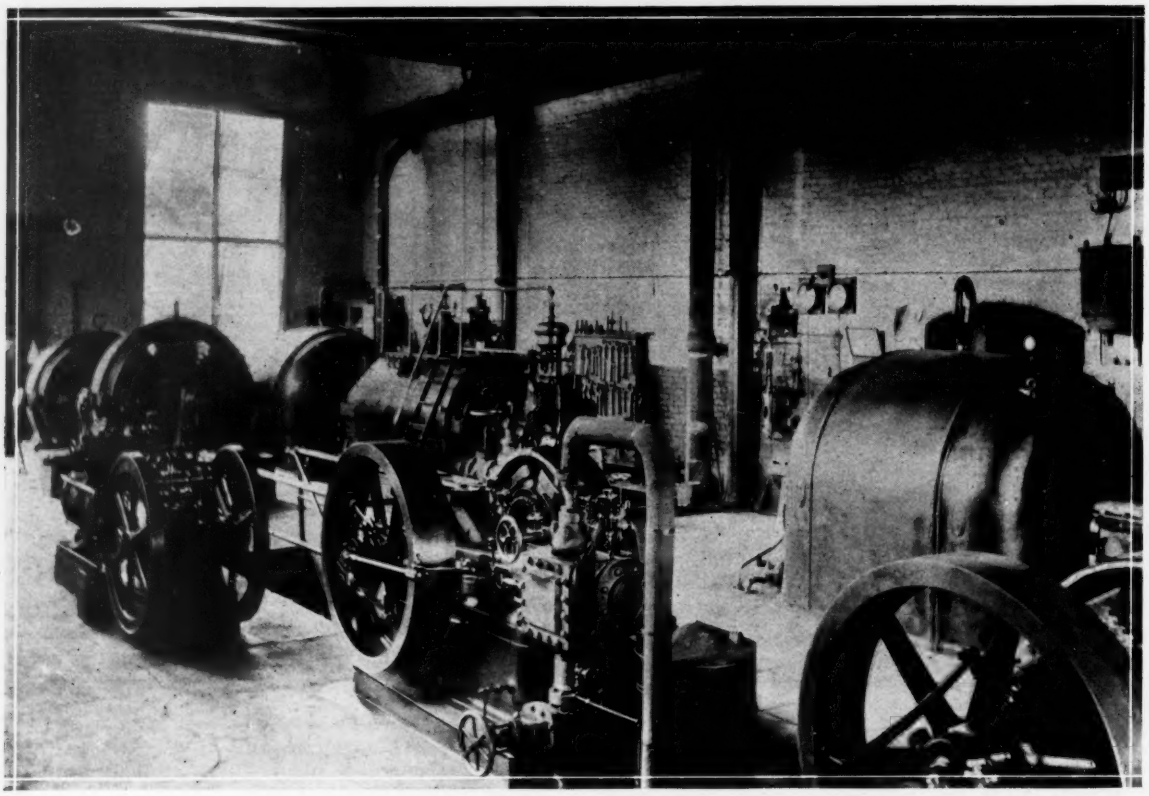


FIG. 3. GENERAL VIEW SHOWING FORMER EQUIPMENT WHICH IS STILL IN USE

The town of Fraser is located in the heart of the coal mining district of Iowa, so that fuel is obtained directly from mines in the neighborhood. This feature

Being a condensing plant, feed water is supplied almost entirely from the hot wells of the surface condensers, the plant depending upon the river for make-

up water. From the condensers the water is delivered to a supply tank in the boiler room, from which it flows by gravity to a Cochrane open feed-water heater. Steam used for heating the water is the exhaust from all pumps and auxiliaries. Three boiler feed pumps then deliver the water to the boilers, 2 being Epping Carpenter 7½ by 5 by 10 in., and the other a Blake 12 by 7½ by 12 in.

Ashes are taken in wheelbarrows to a pit at the rear of the power house, from which they are loaded into cars by means of the crane used also for coal handling.

Turbine Room

IN order to accommodate the new turbo-generator, it was necessary to extend the building and to adapt the apparatus to the new conditions; the switching apparatus and transformers have been located as shown in Fig. 5. Each turbo-generator is a unit by itself, being placed on the main floor, with the condenser directly beneath, with auxiliary pumps grouped around the unit; the arrangement being shown clearly in Figs. 2, 3 and 8.

The generating unit recently put into service consists of a General Electric Co. generator direct connected to a horizontal Curtis turbine, the rating being 2300 volts a.c., 1255 amp., 4000 kw., 1500 r.p.m., steam pressure 175 lb. The exciter is connected directly to the turbine shaft and delivers 320 amp. at 125 volts d.c.

Lubrication of steam turbine bearings has been one of the most difficult problems to solve in regard to their operation. It is interesting, therefore, to note the details of the bearings used with the Curtis horizontal turbine. The middle bearing on this unit is 14 by 42 in. with water cooling coils in the lower half; details of the bearings are shown in Fig. 6. These bearings work under oil pressure, and to adjust this to the proper amount, the baffler shown in Fig. 7 is used.

the intake well is forced through the condenser by a Worthington 18-in. tri-rotor centrifugal pump, which is driven by a direct connected Terry steam turbine running at 1200 r.p.m. under a steam pressure of 175 lb. The hot well pump is also a Worthington centrifugal driven by a Terry turbine and delivers the condensate to the supply tank above the heater.

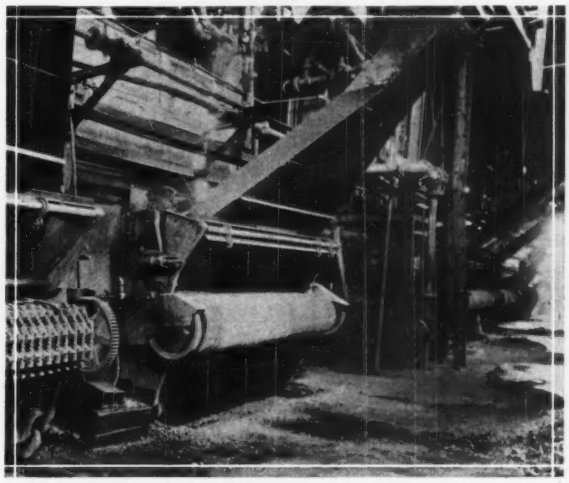


FIG. 4. VIEW IN THE BOILER ROOM

The vacuum pump is located on the main floor and may be seen to the right in Fig. 2. This is a Laidlaw-Dunn-Gordon steam-driven condenser pump, 10 by 21 by 18 in., with a water jacketed air cylinder and an Erie governor.

In case of accident to the condensing outfit, a relief valve on the turbine permits the exhaust steam to dis-

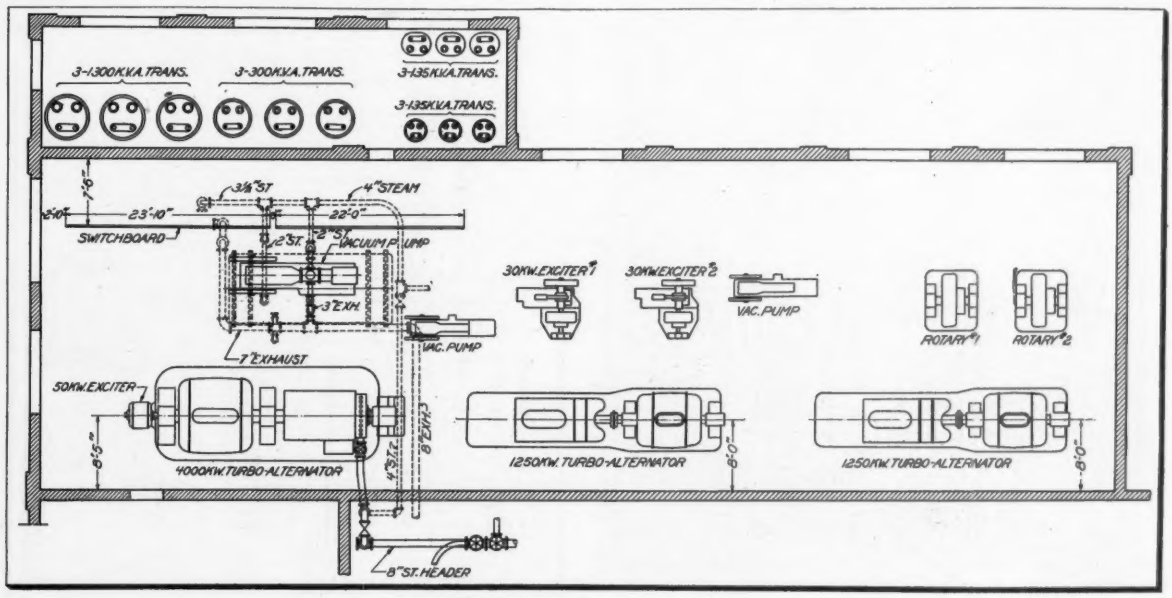


FIG. 5. PLAN OF TURBINE ROOM

Directly beneath the turbine is a Worthington surface condenser, which maintains a vacuum of 28½ in. under ordinary working conditions. Circulating water is obtained from the Des Moines river, and from

charge directly into the atmosphere through a spiral galvanized iron pipe, thus permitting the turbine to be run noncondensing rather than compelling a shutdown.

Aside from the turbine installation just described, there are 2 Westinghouse-Parsons turbo-generator units of equal capacity, which constituted the former

Arrangement of condensing equipment with these units is the same as the new outfit. An Alberger surface condenser is employed, the circulating pump be-

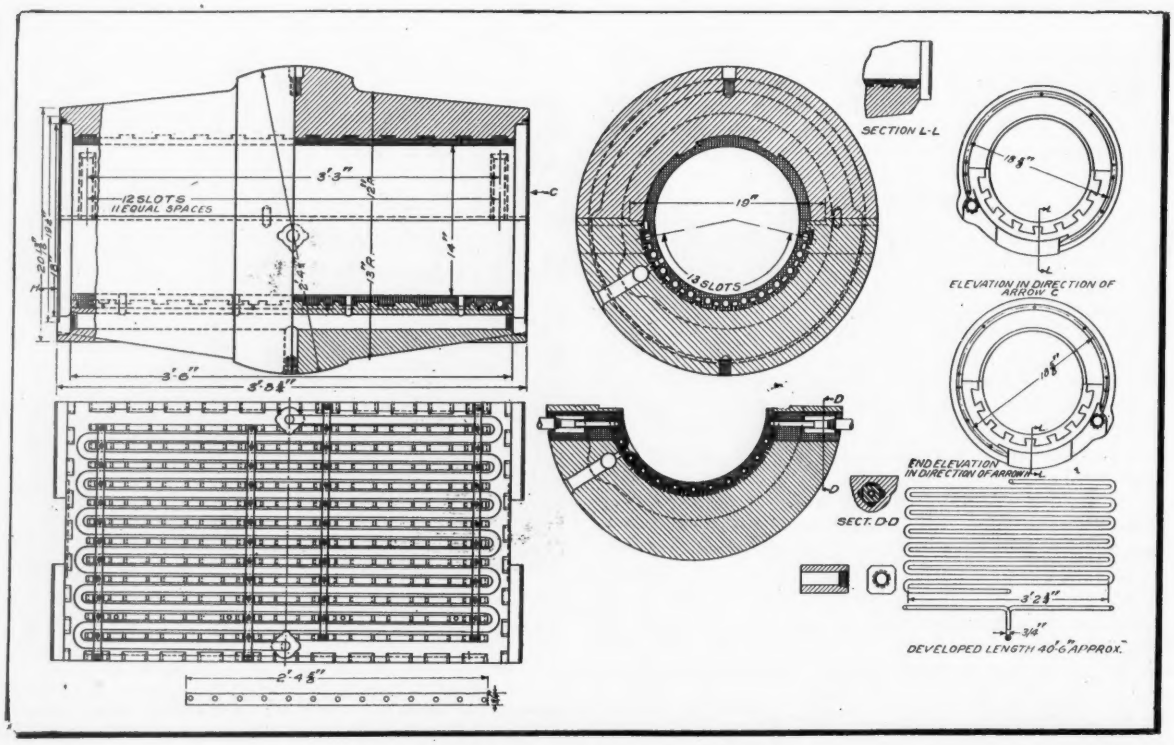


FIG. 6. DETAILS OF TURBINE BEARING

equipment. These are rated at 1250 kw., 2300 volts, 314 amp., 3-phase, 25-cycle, and run at 1500 r.p.m. Separate exciters are used with these units, consisting

ing a 12-in. volute centrifugal, directly connected to a 7 by 9-in. Alberger steam engine. The hot well pump is a duplex 6 by 8½ by 6 in. The dry vacuum

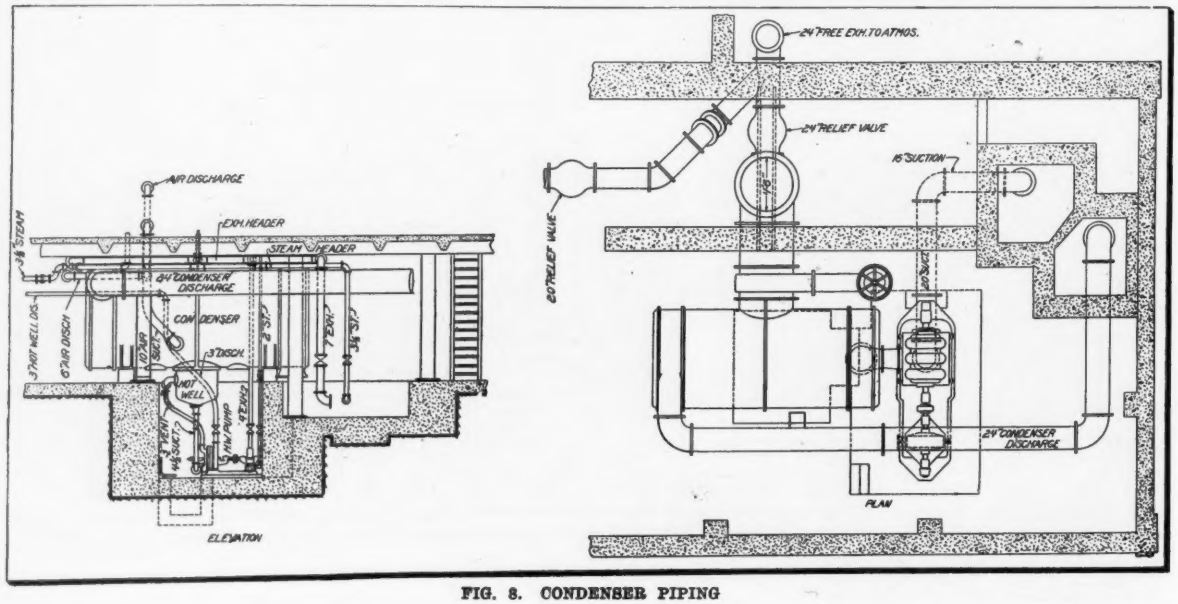


FIG. 8. CONDENSER PIPING

of Ames Iron Works engines directly connected to Westinghouse d.c. generators with rating of 30 kw. 125 volts, 240 amp., running at 270 r.p.m.

pump is of the flywheel type, 8 by 16 by 12 in., made by the Alberger Condenser Co., and located on the main floor.

In connection with the condensing equipment, it may be stated that the plant is on the bank of the river, from which condensing water is taken. To lower the expense of pumping this water, a 6-ft. dam is

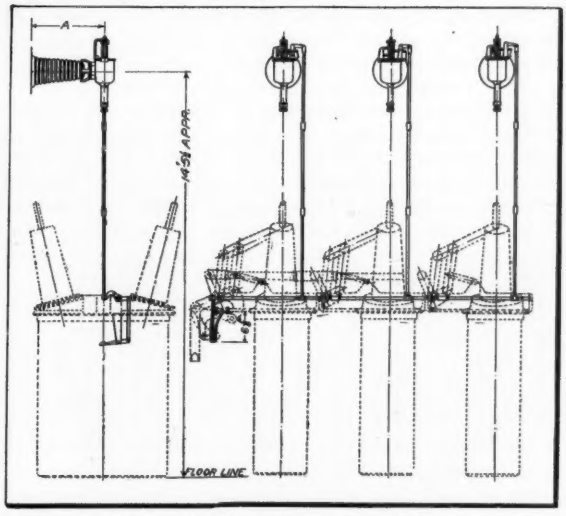


FIG. 10. HIGH TENSION SWITCH SHOWING TRIPPING MECHANISM

placed across the stream, and above the dam a 36-in. pipe conducts the water to a suction well at the plant. Before the water goes to the condensers, it is passed through a series of screens, which effectually removes all fish, debris, etc. The heated water is returned to the river below the dam, through a 36-in. pipe.

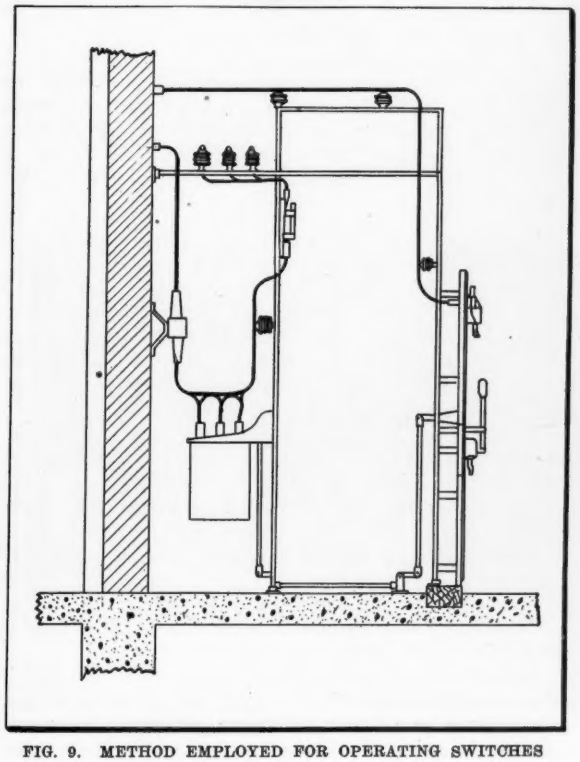


FIG. 9. METHOD EMPLOYED FOR OPERATING SWITCHES

In the engine room are also located 2 rotary converters, which supply direct current for the section of the railroad near the station, and also for some mines nearby. These are Westinghouse units, rated at 400 kw., 600 volts d. c., 670 amp., 3-phase, 25-cycle, and run at 500 r.p.m., they are connected in series, and thus deliver current at 1200 volts to the trolley wires.

Aside from the condensing equipment, there are

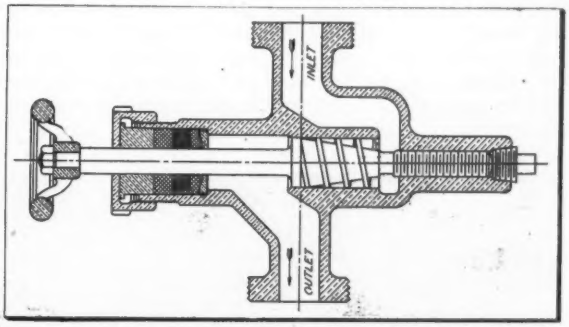


FIG. 7. CROSS-SECTION OF VALVE FOR ADJUSTING OIL PRESSURE ON TURBINE BEARINGS

in the basement, 2 house pumps, one a No. 9 Cameron, the other a Blake 7 by 5 by 12 in., which supply water at 60 lb. pressure for cooling transformers, turbine bearings, etc. A Turner oil filter for cleaning the lubricating oil is also located in the basement.

Switchboard and Transformers

MEANS for handling the electric current after it has been generated must, in the case of a central station or plant transmitting to considerable distance, be

FIG. 11. VIEW IN SWITCH GALLERY

such that uninterrupted service is given. It was with this idea in view that the switching equipment and transformers have been arranged and protected.

The switchboard consists of 23 panels and is designed for an ultimate capacity of 16,000 kw. The

instruments and arrangement are standard for a 2300-volt board, except that in addition to the common indicating instruments, there are a Tirrel regulator, recording volt and wattmeters, power factor meter, synchroscope and a frequency meter. The high tension line switches are located in a gallery above the transformers, but are operated from the switchboard in the engine room by means of bell cranks, to which are attached pipe, thus making the operation of the switch positive.

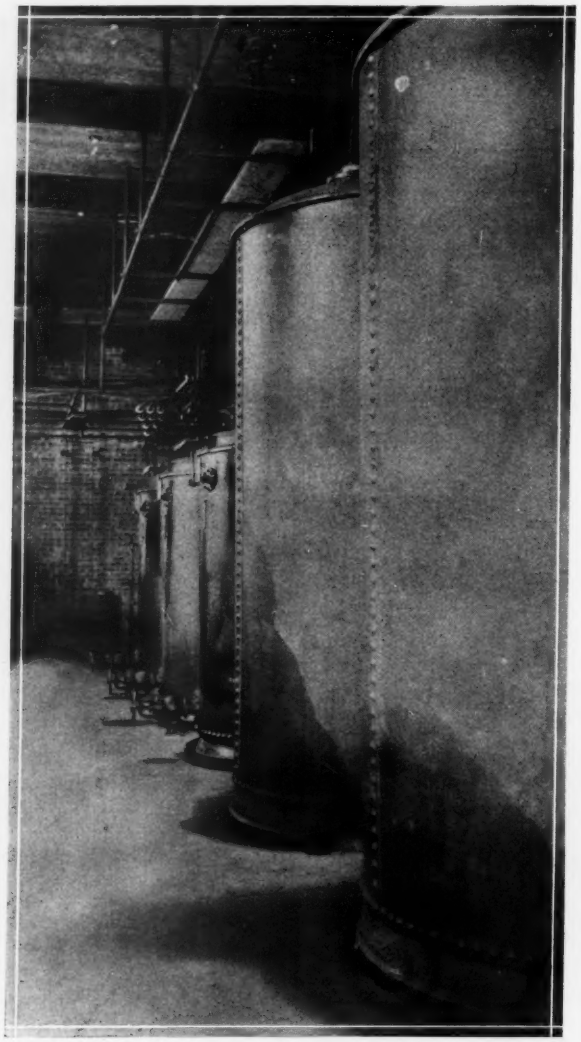


FIG. 12. TRANSFORMER EQUIPMENT

From the switchboard, current is delivered at generator voltage, 2300, to transformers in an adjoining room. In all there are at present 12 water cooled transformers; of these 6 are used to lower the voltage for the rotary converters, the 3 which convert the voltage for the low converters being of Westinghouse manufacture, while the others are General Electric Co. products; all are rated at 135 k.v.a. and step down from 2300 to 390 volts. Of the remainder, 3 Westinghouse transformers are rated at 300 k.v.a. each, and step up from 2300 to 22,000 volts, and 3 General Electric Co. machines are rated at 1300 k.v.a., transforming from 2300 to a transmission voltage of 22,000.

The high tension switching gallery is located just over the transformers, and from it the wires lead directly to the transmission lines. The switches employed are General Electric Type F, with a rating of 200 amp. and 22,000 volts. To provide against a shutdown, in case of accident to any of these switches, a set of transfer buses is provided and an extra set of switches completes the emergency equipment.

Protection from lightning which may come in on the transmission lines is secured by electrolytic arresters and horn type spark gaps, a choke coil being placed in the line between the switches and the connections to the lightning arresters. Water boxes are thrown in the trolley circuit in case of a storm, which effectively protect the direct-current apparatus in the plant and substations from lightning.

From the plant two 3-phase lines run north to Ft. Dodge, while one line carries current to substations south of Fraser. There are 5 substations averaging about 25 miles apart, each equipped with 2 600-volt rotary converters run in series, and 6 transformers, and deliver current at 1200 volts for interurban service and 600 for service on street railways. In all, 125 miles of roadway are served, which includes towns and cities between Ft. Dodge and Des Moines, and Rockwell City and Ames. Power is also furnished for local car lines at Ft. Dodge and Ames, besides numerous coal mines and industrial plants.

In order to bring up the load factor of the plant, the train schedule has been arranged, as nearly as possible, to eliminate a peak load. Seven passenger trains are in operation during the daytime, running all the time. These have from one to 4 cars each, and are equipped with multiple unit control. During the night, 8 freight trains are kept running, having from 6 to 40 cars each, and hauled by electric locomotives.

The operation of this plant is under the direction of C. H. Crooks, vice-president and T. J. Richards, the chief engineer, and the engineering work connected with the extension of the plant was done by Woodmansee & Davidson, consulting engineers of Chicago, to all of whom the writer is indebted for information and blueprints.

In New York City a children's safety crusade has been carried on since last December by the American Museum of Safety with the hearty co-operation of the Board of Education. Its object is street safety for children and the basis of the campaign is daily class room talks followed by the distribution of pamphlets containing "safety fairy tales," which the children are encouraged to take home and discuss with their parents.

Never fail to look both ways before crossing a street. Keep eyes to left until the middle of the street is reached, then eyes to right until the curb is reached.

Never play any kind of a game in street where automobiles, heavy trucks or trolley cars are passing.

Never hitch on behind a trolley car, automobile or motor truck.

Never run pushmobile races in the streets.

Never step from behind a trolley car without looking for another car coming from the other direction.

In addition to street safety, the children are taught what to do in case their clothing catches fire or in case there should be a fire in the house, and are also warned against cluttering the fire-escapes of their homes with household effects.

Caution and self-control are at the root of the lesson taught; to train the children of today to be the prepared workers of tomorrow, to meet modern industrial conditions where the element of danger is always present.

LINING A 4-BAR GUIDE

How to Do This Accurately with Tools Improvised in the Engine Room

By F. W. Bentley, Jr.

THE writer, as a result of not a few years spent in "hiking" from one engine room or plant to another with a kit of machinist's tools, readily sympathizes with the engineer who is often caught by an unexpected breakdown—unprepared for the contingency through a lack of tools and sometimes by an absence of a ready knowledge of how to tackle the proposition. It is true, of course, that the principal obligation of the engineer to his job consists in running the machinery under his charge and not the repairing of it, but the instance very often occurs where the services of a mechanic cannot be immediately secured, and still more often only until after a partial or prolonged shut-down paralyzes the establishment.

It is most assuredly a fact that a great many classes of mechanical repair or construction work necessitate the use of a host of varied and accurate tools, but nevertheless a great portion of the general run of engine room repair work that seemingly requires a glittering array of mechanical instruments can be executed without them. The above statement is intended in no manner to leave the impression that accurate work should be performed by careless or unreliable methods, but to bring out an undeniable fact that the true mechanic is the one who can execute the most difficult task with the assistance of the fewest and crudest tools which he may chance to have at his disposal. This latter assertion is made with no intention of emphasizing any personal ability, but as an honest conviction the result of a long period of employment as job machinist affording a close and intimate association with brother mechanics, many of them justly entitled to the distinction of being geniuses at the trade.

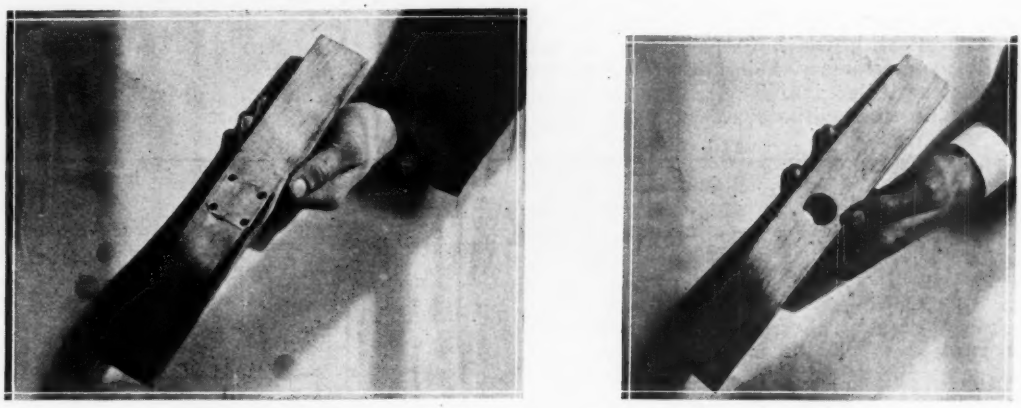


FIG. 1. THE 2 SIDES OF THE CENTERING STRIP FOR COUNTERBORE

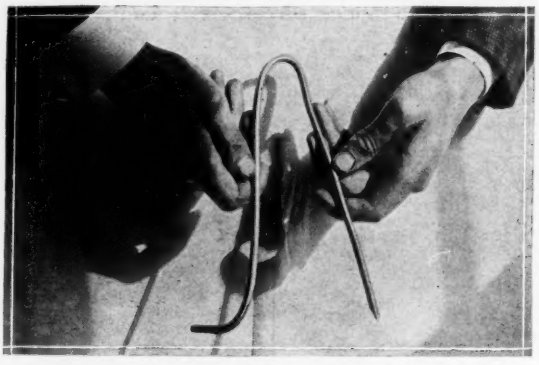


FIG. 2. IMPROVISED HERMAPHRODITE DIVIDERS

The proper and accurate alinement of a set of 4-bar guides is by no means a difficult and lengthy piece of work when a special set of tools for that task are at hand, but the job it must be acknowledged will develop into a proposition presenting some tremendous difficulties if the only actual working implements chance to be of the kind generally found in the average engine room.

Before entering the following description of a primitive but reliable and accurate method by which to do this piece of work, the author wishes to relate a few facts which in one sense of the word are intended to serve as an explanation and in another sense to explain the spirit of helpfulness in which the article is written. Some years ago the writer was ordered by his shop foreman to a small town about 80 miles distant, to line a set of 4-bar guides on a simple engine; the crosshead had been refitted with new and heavier

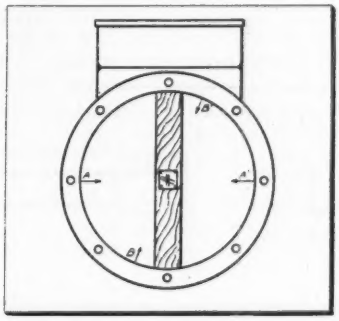


FIG. 3. FINDING THE COUNTERBORE CENTER

brass gibs at the same shop. The writer's tools and the crosshead were forwarded by express on the same train. The crosshead was thrown off at its proper destination but a careless messenger allowed the tools to be carried on by oversight, and the author, arriving

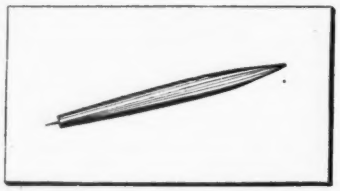


FIG. 4. THE STICK AND PIN CALIPER

on a train a few hours later, found only an innocent looking crosshead with which to pacify an excited manager of a local creamery, a disconcerted engineer and a sadly dismantled engine. The job was, however, completed in due time without access to the ever-ready tool kit, and the following explanation of the method used to do it is subject to criticism if there be any, yet at the same time it is offered for the reader's help in a similar contingency.

The first and preliminary step to be taken on a job of this kind is the stringing of a center line through the center of the cylinder counterbore at its front end, and from this point through the center of the stuffing box. The string or thread used for this purpose should be strong and elastic, in order to stand the strain of being tautly drawn and permanently held in place. When so centered and fastened it is in the exact center of the path travelled by the center of the piston, piston head and piston rod fit in the crosshead. The line is used to place the 2 lower guides at the proper distance below or above the center of the cylinder as the case may be, to correspond with the same distance measured from the center of the piston rod fit in the crosshead to the faces of its lower gibs. The exact center of the cylinder must now be found and fixed from the inside circumference of the forward counterbore.

Take a narrow strip of soft pine wood a trifle longer than the diameter of the cylinder counterbore. At its exact or near center bore a hole about an inch in diameter, over which tack a piece of thin bright tin. Fig. 1 will make this clear in detail. Jam or drive the stick into the counterbore of the cylinder, the side on which the tin is fastened being brought flush with the joint face for the head, Fig. 5. Now with a large pair of hermaphrodite dividers or if there is none at hand construct a pair of heavy wire, Fig. 2, scribe lightly 4 arcs centering from points A A^1, B B^1 on the counterbore to the tin plate, these arcs being after a few trials tangent to each other and bisecting in pairs at a point which is the exact center of the cylinder, Fig. 3. Squarely through this point punch a fine hole just sufficient to allow the centering thread or string to pass and be held by a small knot. The center of the cylinder and one end of the center line are now permanently located. Carry the line now on through the stuffing-box and secure the free end of it to the crank pin, which should be located close to the forward or back center and the flywheel blocked. The flywheel, however, should not be secured in such a manner that it will later on be difficult to move it while vertically centering the line through the stuffing-box.

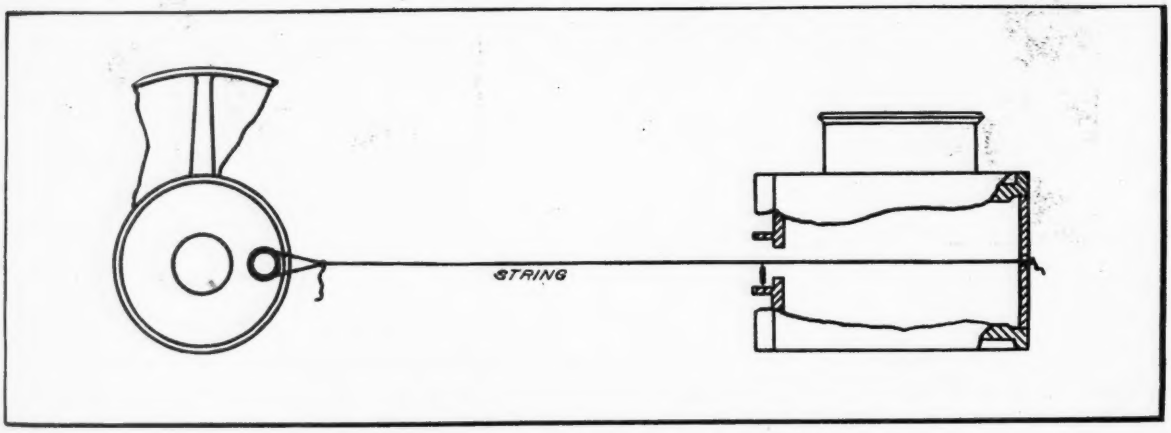


FIG. 5. THE CENTER LINE IN PLACE AND ITS SUPPORTS

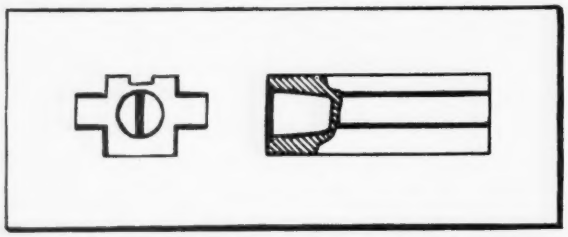


FIG. 6. USE OF HEAD STRIP TO GET CROSSHEAD CENTER

FIG. 7. HERMAPHRODITE CALIPERS FROM A COTTER PIN

The line should now be brought to pass directly through the center of the stuffing-box. In case there be no calipers at hand with which to try the location of the line from the inside circumference of the stuffing-box, manufacture a crude, but nevertheless accurate, micrometer by means of a small pine stick and a common pin. Fig. 4 is an illustration of such a ready-made tool. The stick pointed at one end should be in length slightly less than one-half the inside diameter of the stuffing box.

By pulling the pin in and out a trifle while trying the location of the string from the walls of the stuffing-box, the cord can soon be centrally located by moving it laterally on the wrist pin or slightly moving the flywheel either way for vertical centering of the

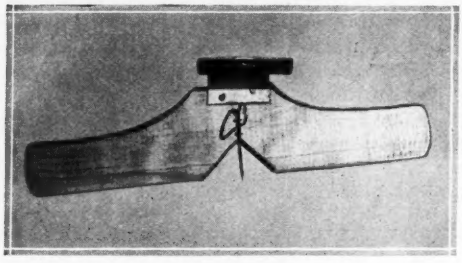


FIG. 8. DETAIL OF GUIDE LINER

line. The completion of this part of the job affords a permanent marking and guide of the path travelled by the center of the piston, piston head and consequently the portion of the crosshead into which the piston rod is secured. Figure 5 is a detail of the whole centering operation.

The next and practically the final step is the placing of the lower guide bars at the same distance from the centering line as that measured from the center of the piston rod fit in the crosshead to the faces of its lower gibs. The exact center of the piston rod fit in the crosshead should now be located. Take a piece of lead and jam it down into the opening flush with the end of the head, Fig. 6. In the absence of hermaphrodite calipers with which to scribe centering arcs

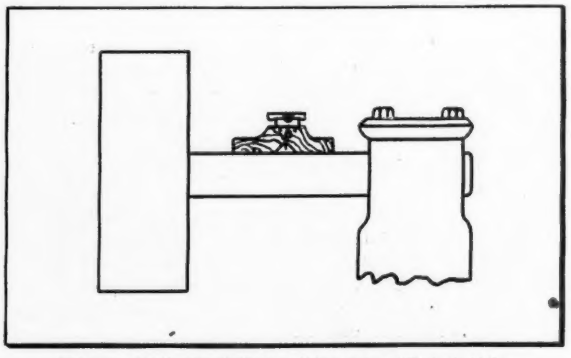


FIG. 9. USE OF GUIDE LINER TO LEVEL SHAFT

on the strip of lead from the circumference of the fit, a fairly good substitute for that tool can be quickly made from a spring cotter or cotter-key, Fig. 7. Make the center mark very distinct.

The remaining work from this point requires the use of perhaps the most complex, but nevertheless simply constructed device—a guide liner. Figure 8 is a cut that will help to illustrate clearly its purpose. A wooden strip about 8 or 9 in. long in accordance with the over-all width of the guides when in place, should be notched out at its lower central portion. The lower face of the strip should be perfectly straight and true as it is placed on the faces of the lower guides during the levelling and alining operation. Through the center of the groove a pointed piece of wire should extend fastened at its upper end by 2 small staples in such a manner so as to be moved freely before it is

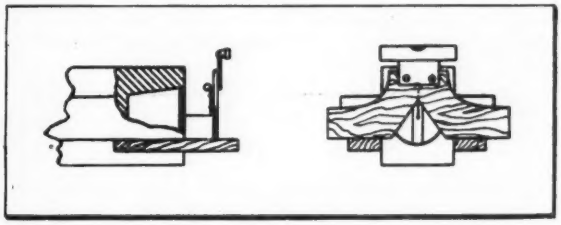


FIG. 10. GETTING DISTANCE FROM LOWER GUIDE TO CROSSHEAD CENTER

permanently secured by driving in the staples. To the upper or top portion of the device a piece of thin sheet metal should be tacked for the purpose of fastening over it a common carpenter's level. The following and finishing work done with this device is entitled to a more lengthy but none the less simple explanation.

The liner should be placed on the main or balance wheel shaft to make certain that it is level, Fig. 9. Now place 2 strips of wood or metal against the lower gibs of the crosshead. Bring the bottom face of the liner against them over the top of the crosshead and place the point of the wire over the punch mark in the lead strip indicating the center of the piston rod fit in the crosshead. Figure 10 will make this clear. The liner will now show the exact distance the lower guides should hang below or above the center string.

Hang the 2 lower guides temporarily, and lay the liner across them. The level will show when the 2 guides are laterally level with the main shaft. The pointer when just touching the string at either end will show the distance the lower guides should be from the

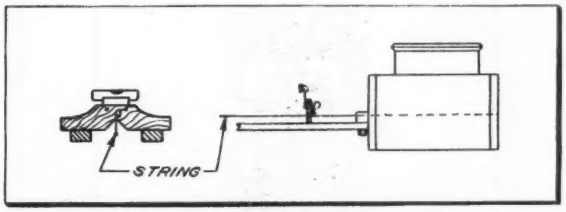


FIG. 11. LOCATING THE LOWER GUIDES FROM THE CENTER LINE

center-line in order to give a perfect alinement with the piston and crosshead when they are in place. This is accomplished of course by removing or inserting the block shims at each end of the bars. Figure 11 will make the application and use of the liner very clear.

The remaining portion of the job consists in simply placing the top guides so that the crosshead will travel snugly but freely between them and the lower guides.

WHAT WE CAN DO is a small thing; but we can and will aspire to great things. Thus, if a man cannot be great, he can yet be good in will; and what he, with his whole heart and mind, love and desire, wills to be, that without doubt he most truly is.

HEATING AND VENTILATING LARGE BUILDINGS

Equipment for Vacuum Heating

By Charles L. Hubbard

THE present article takes up in detail some of the special apparatus used in vacuum heating. This has been chosen at random from the many different makes upon the market, with a view to illustrating as great a variety as possible, and not with the idea of advertising or recommending any particular make.

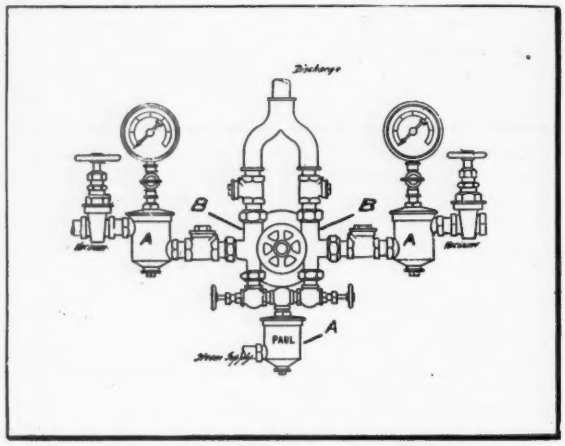


FIG. 1. DOUBLE STEAM EXHAUSTER

The exhauster commonly employed in the Paul System for producing a suction upon the air line is shown in Fig. 1. This is a double exhauster, the air lines being connected with the valves marked "vacuum" in the cut. The strainers A, A, A, are for removing any sediment or scale which may be carried

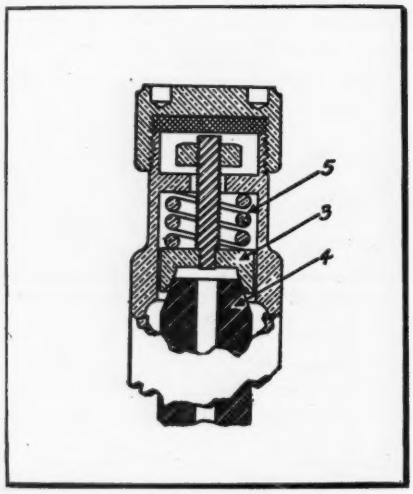


FIG. 2. SECTION OF RADIATOR AIR VALVE

along with the air and steam and tend to clog the ejectors B B. In operation, live steam enters the side of the lower strainer, at the point indicated, passes upward through the ejectors and out through the discharge then creating a partial vacuum in the air lines. The reduced pressure is indicated by 2 vacuum gages connected with the strainers in the air lines. Shut-off and check valves are provided where shown in the cut and are so arranged that either ejector may be used independently of the other.

A special form of radiator air valve for use with this system is shown in cross-section in Fig. 2, to illustrate its principle of operation, 4 is a vulcanite expansion tube, 3 a metal valve seat, and 5 a compensating spring for preventing too great a pressure being exerted between the expansion tube and valve seat.

When the valve is filled with air the vulcanite tube contracts away from the metal, thus forming an outlet through the center, but when the air has all been discharged, and steam strikes the vulcanite, it expands and closes the outlet.

In the other type of vacuum system, where the suction is applied to the main return and draws out both air and condensation, some form of pump is required. A common form of vacuum pump designed

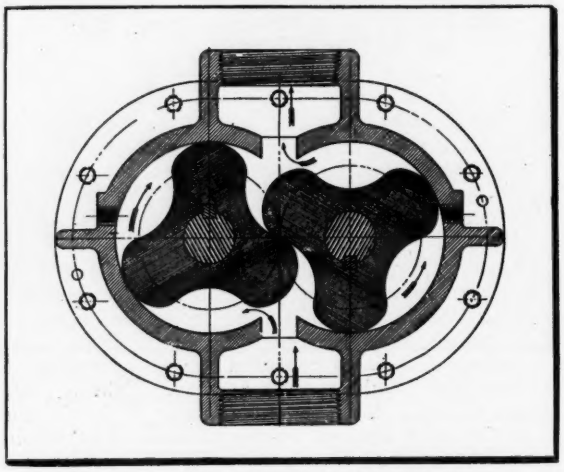


FIG. 3. SECTIONAL VIEW OF ROTARY PUMP

for this special purpose is a single cylinder steam pump of the direct-acting type, and is especially adapted to this class of work because the speed may be easily adjusted to produce the amount of vacuum required. This is an important feature where it is desired to regulate the temperature in the building by varying the pressure in the radiators. The table gives the size of vacuum pump required for handling the condensation for different amounts of direct radiating surface.

Two pumps should be provided, each of a capacity for doing the entire work, and the exhaust turned into a feed-water heater or into the general heating system with that from the engines.

SQUARE FEET OF RADIATING SURFACE CARED FOR BY VARIOUS SIZES OF PUMPS

Size of Pump	Square feet of Radiation
4 by 5 by 5	3,000
4 by 6 by 7	7,000
5½ by 8 by 7	15,000
6 by 9 by 10	30,000
6 by 10 by 12	40,000
8 by 12 by 12	60,000

A vacuum pump of the rotary cycloidal type is especially adapted to an electric drive. It is made in sizes having a displacement of 40 to 10,000 gal. per minute and serves both as a vacuum and a feed pump. One advantage of a pump of this type is that it will handle water of any temperature, which is not true of the piston pump. The section shown in Fig. 3 illustrates the principle of operation. Figure 4 shows a device which is made in forms adapted to either type of vacuum system. For air line systems the apparatus consists of a motor-driven centrifugal pump, a turbine ejector or vacuum head, a water storage tank and an automatic controlling device. In action the centrifugal pump forces a stream of water at a high velocity through the ejector, thus producing the desired vacuum upon the air line which is connected with it.

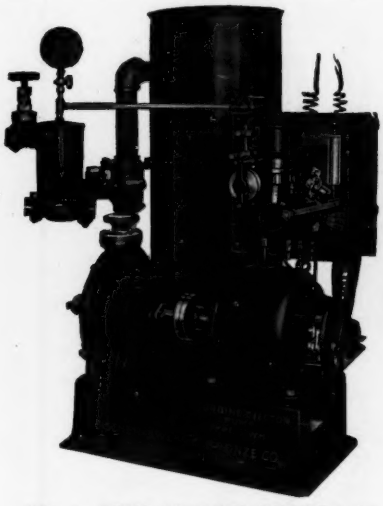


FIG. 4. PUMP ADAPTED FOR USE ON EITHER TYPE OF VACUUM HEATING SYSTEMS

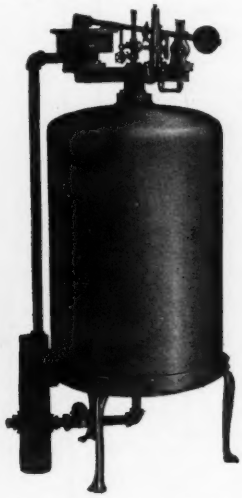


FIG. 5. AIR LINE VACUUM PUMP

When used on return lines, where a high vacuum is not required, the pump is run continuously to take care of the condensation as fast as it is returned. In this case the automatic controlling device is replaced by a regular starting switch and rheostat. When used in connection with a boiler carrying a pressure of less than 10 lb. the condensation may be returned direct to the boiler; but for high-pressure plants, a receiving tank and feed pump are necessary.

The vacuum pump shown in Fig. 5 is for producing a vacuum upon the air line, the condensation flowing to the receiver the same as in the Paul system. This pump consists essentially of a tank, a thermostat, and a diaphragm motor which operates a pair of valves for admitting steam and water to the tank. The vacuum is produced by first admitting low-pressure steam to the tank and thermostat. The action of this is to vaporize a volatile liquid in the thermostat, thus producing sufficient pressure upon a diaphragm and connecting lever to shut off the steam valve and open the water valve. As the water spray is discharged into the tank, the contained steam is condensed and a vacuum produced. At the same time the spray cools the thermostat, thus removing the pressure from the diaphragm, closing the water valve and shutting off the spray. The air line is brought into the tank and the operation above described is repeated automatically as often as necessary to maintain the desired vacuum. This device is manufactured by the Automatic Pump Co., Chicago.

Having considered some of the different methods of producing a vacuum in the air or return line, let us now take up several of the various automatic valves used upon the return ends of the radiators in the return line system, where the air and condensation are drawn out together. Most of these valves are either of the expansion or float type.

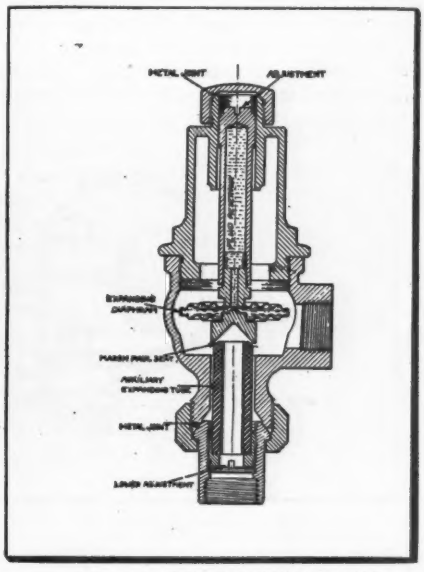


FIG. 6. SECTIONAL VIEW OF THE REFLEX VALVE

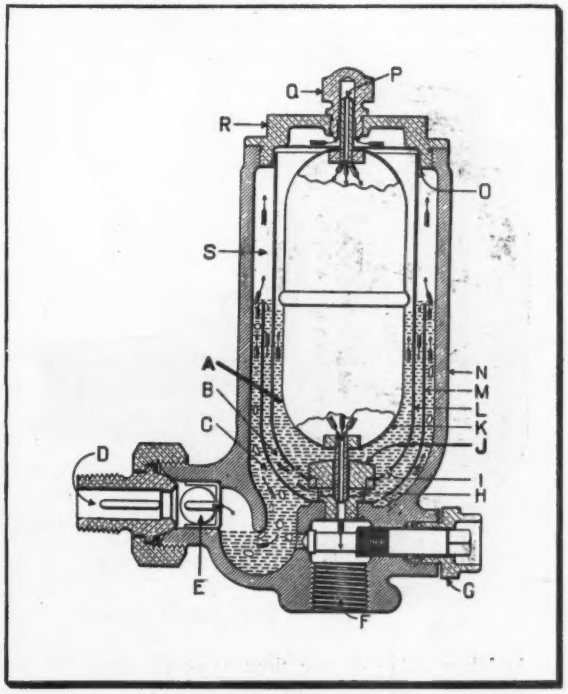


FIG. 7. MONASH-YOUNKER RADIFIER VALVE

The Reflex valve, illustrated in Fig. 6, made by James P. Marsh & Co., Chicago, combines the closed double diaphragm with a volatile liquid and the composition expansion tube. One essential feature of

this valve is the fluid reservoir above the diaphragm which relieves the force of the expanding members and thus prolongs the life of the valve. When cold, the valve is open, thus preventing the accumulation of water and any danger of freezing.

The Monash-Younker Radifier valve is shown in Fig. 7. This is attached to the radiator at D and to the return line at F. In action air and water enter

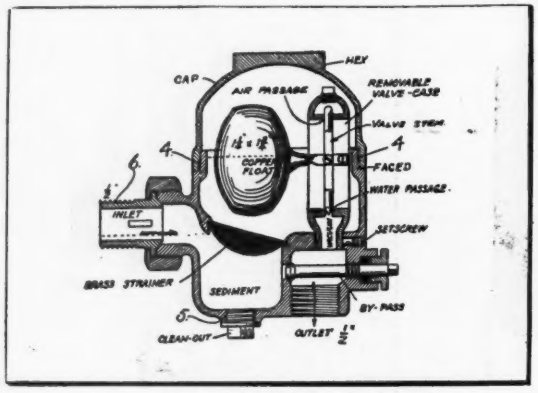


FIG. 8. ROCHESTER VACUUM VALVE

at D past the check E and into the space C, where they separate, the air rising upward through opening O to the hollow guide pin P, then downward through the hollow float K to the outlet at F. The water in the meantime rises in the space C and overflows into B, from which it passes into A through small openings near the bottom. When the level reaches a certain point, which is about midway of the float, the latter rises, thus opening the valve at the point H and allowing the water to drain from the chamber A into the return line through F.

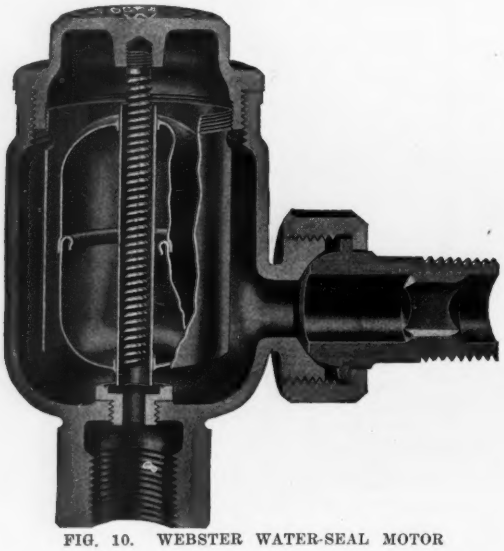


FIG. 10. WEBSTER WATER-SEAL MOTOR

Another valve of the float type is shown in Fig. 8. The different parts of the device are clearly indicated in the cut and require no special description. When first starting up the vacuum sucks out the air through the air passage. The condensation rises in the main chamber until it raises the copper float and opens the water passage communicating with the outlet; the action now, as far as the discharge of water is concerned, is practically the same as an ordinary float trap. The float chamber is always in communication with the vacuum chamber through the air pas-

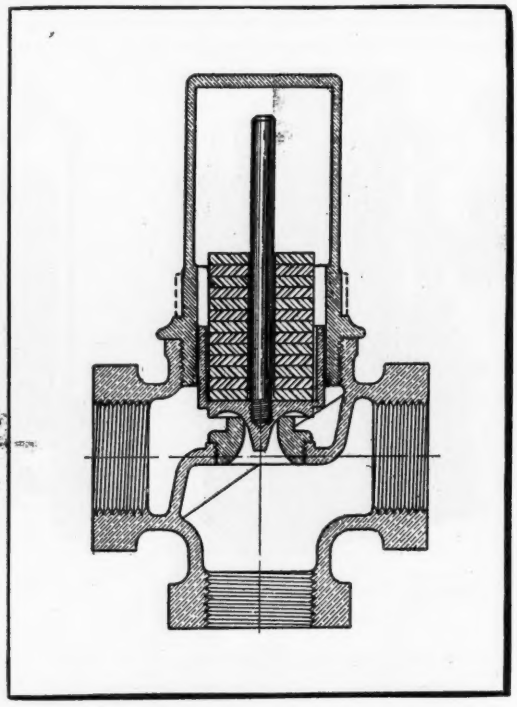


FIG. 11. POSITIVE DIFFERENTIAL VALVE

sage, which is choked with a piston valve disk, leaving 1/64-in. space around the disk for the passage of air and vapor.

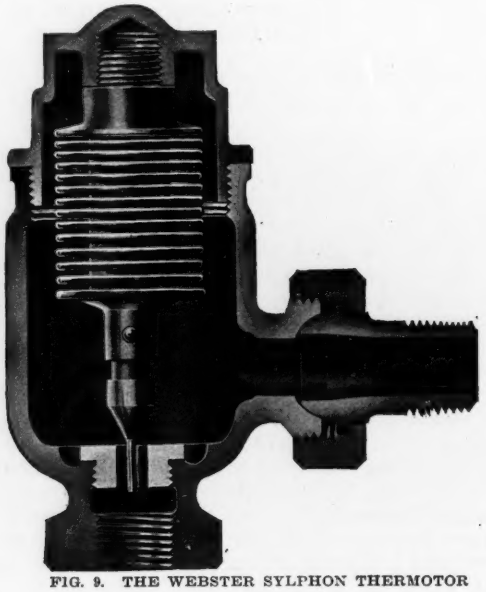


FIG. 9. THE WEBSTER SYLPHON THERMOTOR

Figure 9 shows the latest type of Webster automatic valve for the return end of radiators. It is thermostatic in principle, exceedingly flexible, giving a large lift from seat thus permitting dirt to pass through the port, good for widely varying pressures,

permitting water and air to pass while tight against steam leakage, durable and noiseless; possessing all the qualities necessary for a perfect return valve for a steam-heating system, combined in one valve. The thermostatic member is of the Sylphon bellows construction. The seat is large in area and removable.

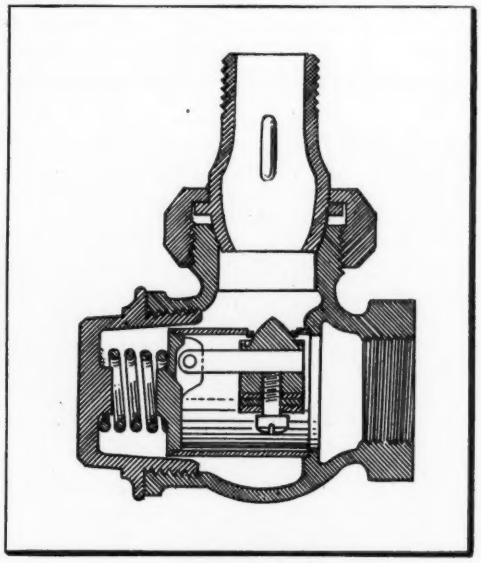


FIG. 12. IMPULSE CHECK VALVE

The Webster water-seal motor is shown in Fig. 12. This consists of an outer shell containing a copper float which slides upon a vertical threaded stem. The lower end of the float forms a valve which opens and discharges the contained water when the level reaches a certain height. The air is drawn out through the spiral opening formed by the thread upon the stem, and

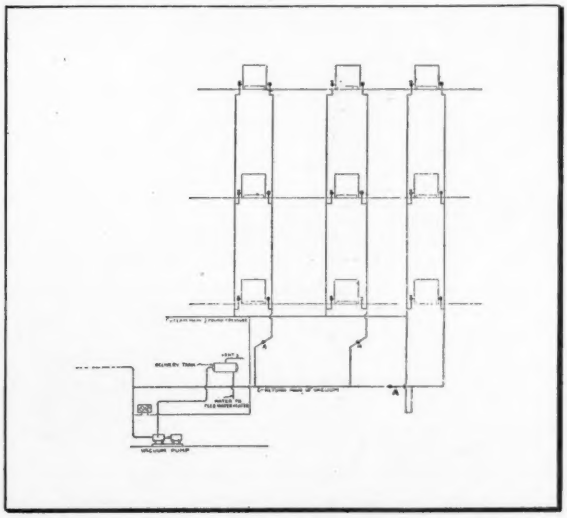


FIG. 13. POSITIVE DIFFERENTIAL SYSTEM OF PIPING

which does not admit of the passage of steam, owing to its peculiar form.

The equipment used in the Positive Differential System is illustrated in Figs. 11, 12 and 13. The differential valve, Fig. 11, is simply a weighted relief valve and is placed in each return drop below the radiators, see A A A in Fig. 13. The impulse check, shown in Fig. 12 is attached to the return ends of the radiators. Differential valves are commonly weighted to open at about 5 lb. difference in pressure on the 2 sides. In operation the vacuum is started and the air exhausted from the return lines until a sufficient vacuum is obtained to open the differential valves thus producing a uniform flow through each into the main return. As the air in the pipes between the differential valves and the radiators is exhausted the impulse checks on the radiators open and discharge the air and condensation which they contain into the return drops. In brief, the office of the differential valves is to maintain a uniform vacuum in all of the return drops throughout the system, while the impulse valve serves the same purpose as the automatic valves previously described; that is, opening when sufficient water collects against the swinging check to open it.

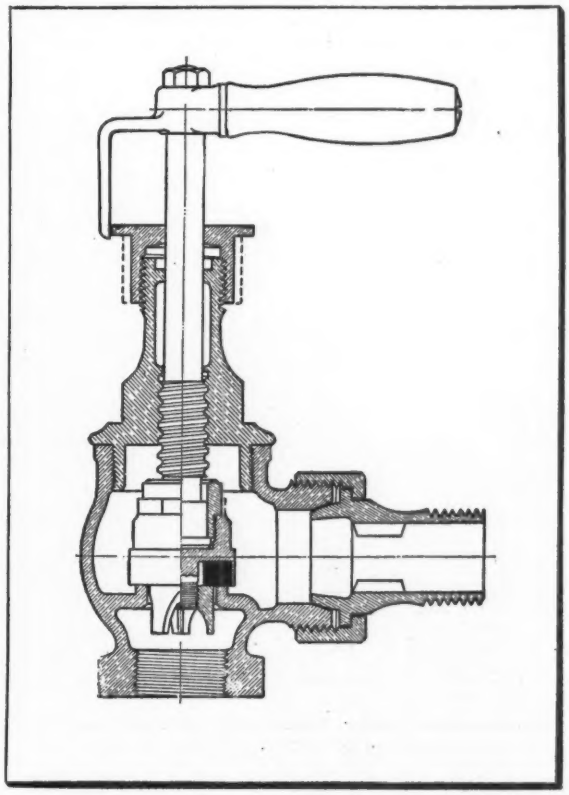


FIG. 14. SECTIONAL VIEW OF GRADUATED RADIATOR VALVE

The valves upon the supply ends of the radiators in any vacuum system, where a suction is applied to the main return, may be either of the usual shut-off type, the graduated hand valve or the pneumatic valve. In the first case there will be no individual regulation of the different radiators except as they are shut off or turned on. With a properly designed graduated valve no more steam need be admitted to the radiator than is desired for warming the room, provided it is not throttled to such a point that the pressure falls below that in the return line. Pneumatic valves are used in connection with certain systems of automatic temperature control and will be described later.

A section through a common form of graduated valve is shown in Fig. 14.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

ELEVATOR SAFEGUARDS

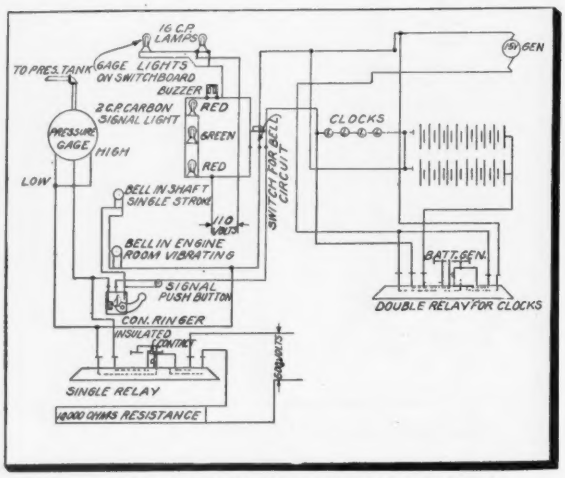
Signal System to Indicate When Power Is Off

By A. J. Zimmerman

At our plant in the Firemen's Insurance Building, Newark, N. J., we have plunger hydraulic elevators. The pumps are motor-driven by central station current of 500 volts d.c.

We found it necessary to devise a signal system that would give an alarm in engine room and elevator shaft, when the 500-volt circuit would fail or the automatic motor starter failed to start on low pressure or stop on high pressure.

We installed a single relay in series with 10,000 ohms resistance on our 500-volt circuit, the armature of relay being held against insulated contact point as



WIRING OF ELEVATOR SAFEGUARD SYSTEM

long as the 500-volt circuit is alive. On failure of the 500-volt circuit, a spring pulls the armature against the contact connected to a continuous ringer, causing a drop to fall and thereby make a continuous contact.

For high and low-pressure alarm, we installed a Crosby pressure gage with fixed contact points at 130 lb. low and 210 lb. high. Both of these contacts are connected to ringer circuit the same as the 500-volt relay.

The bell in the elevator shaft is single stroke (so as to do away with a contact in an unhandy place that would be apt to give trouble) and is connected in series with vibrating bell in engine room. The bells are supplied with 15 volts d.c. from an a.c.-d.c. motor generating set, and are taken from the same contacts as our clocks. This circuit is taken care of by a double relay with the magnets connected to generating set. In case of failure on our light a.c. circuit, the relay cuts in a double battery of 10 cells.

In case of failure on our 500-volt circuit, after the bells have given the alarm, we have a 3-pole switch to open bell circuit to stop the ringing. As this switch if left open and forgotten would render the system useless, we have a telltale in 3 colored 2-c.p. lights and a buzzer (which being operated on alternating current needs no vibrating contact) which is connected in multiple series with 2 16-c.p. lights on switchboard, which burn continuously. One blade of the 3-pole switch is used to short-circuit the colored lamps and buzzer when closed; but when opened colored lamps burn bright, buzzer is operated and as the 2 16-c.p. lamps on switchboard burn dim, the colored lamps show up well.

We find this system very helpful and it adds much to the safety of the equipment, because in case of current failure the pump stops delivering water to the pressure tanks and where the motors are normally stopping and starting it is easy to overlook the fact that the motor has stopped for a longer period than usual.

As we carry about half a tank of air, to make the system run smoothly, it does not take long to draw the water down low enough to admit air into the system, which is dangerous.

This alarm warns engineer and elevator operator and puts them on their guard.

After 500-volt current has been restored, we give 3 rings with push button as O.K. signal.

A large waterpower plant for the generation of electricity enough to supply Louisville is to be built on the Chaplin River in the eastern part of Nelson Co., Ky., according to reports. Options on several pieces of land skirting the river at a point near the famous Sutherlands mill have been secured by a Chicago man who has been here investigating for the last 2 weeks. The depth and fall of the river is well adapted for the operation of water engines at a point near the Sutherlands. The man who secured the options said that Chicago people are interested in developing waterpower sites within 50 miles of Louisville and said further that a staff of engineers would be down here soon to make surveys and test the flow of Chaplin River. It was hinted that the Byllesbys are the ones chiefly interested in the proposed development of this waterpower site for electrical generation purposes.

We sleep, but the loom of life never stops, and the pattern which was weaving when the sun went down is weaving when it comes up tomorrow.

—Beecher.

HIGH VOLTAGE DIRECT-CURRENT LOCOMOTIVES

For Use on the Butte, Anaconda & Pacific Railway, Taking Current at 2400 Volts

THIS installation is of interest as representing one of the largest electrical equipments for steam railroad service, and the first in the United States where direct-current locomotives using as high potential as 2400 volts have been employed.

This voltage was adopted, after comprehensive study in comparison with other existing systems, because it seemed best suited for the exacting service of this character, and gave an opportunity for unusual economy in initial expenditure and cost of operation.

The section of the road equipped for electrical operation lies between Butte and Anaconda, Mont., and comprises 30 miles of main line single track, with sidings, yards, etc., making a total of about 90 miles single track.

The freight hauled, including copper ore, mine supplies, lumber, etc., amounts to practically 5,000,000 tons a year. Complete freight trains consist of 50 loaded steel ore cars, weighing 3400 tons total, and will be handled over a grade ruling 3 per cent, by a locomotive consisting of 2 of the units illustrated herewith. Single units will be used to make up trains in the yards and for placing cars.

Seventeen locomotive units will make up the initial equipment, 15 for freight and 2 for passenger service, each unit weighing 80 tons. The double unit freight locomotive, operated in multiple, will haul the usual train at 15 miles an hour against 3 per cent grade and at 21 miles an hour on straight level track.

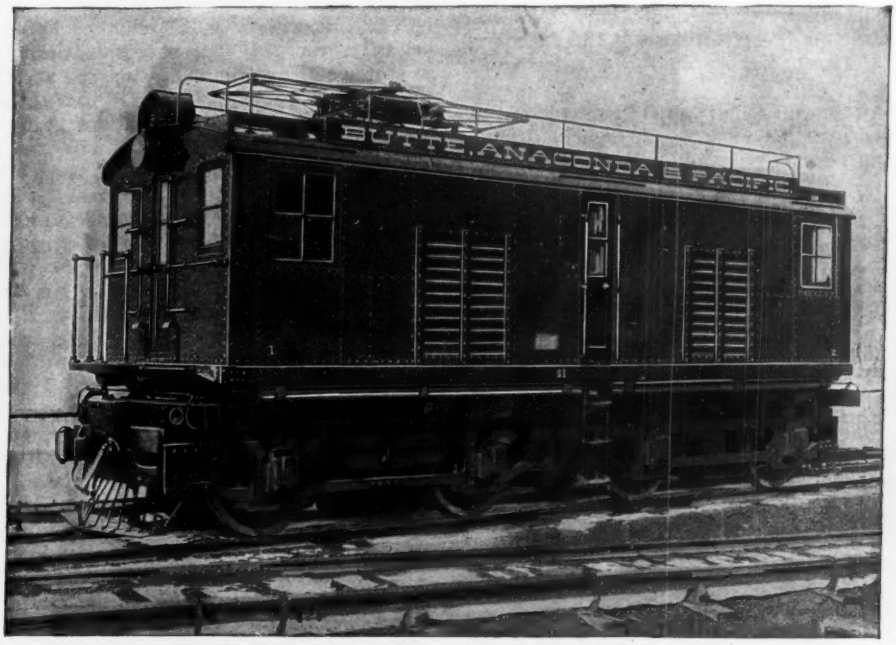
Passenger locomotives are of the same designs as freight, but are geared for 45 miles an hour on straight level track. Four standard passenger trains, consisting of locomotive and 3 coaches will be operated each way, each day. All locomotive equipment, substation apparatus and overhead line material was furnished by the General Electric Co.

The motors are of commutating pole type, wound for 1200 volts and insulated for 2400 volts, operating in series multiple — that is, 2 motors are always worked in series and 4 series may be put in multiple by the controller.

Forced ventilation is provided by the rotation of the armature, keeping all parts of the motor at uniform temperature. The continuous capacity of each motor is 190 amp. under forced ventilation, and for one hour rating, 225 amp. For the double unit freight locomotive, this is equivalent to a continuous output of 2100 hp.

Sufficient resistance points are provided on the controller to give very smooth operation in starting, so that tractive effort close to the slipping point of the wheels is maintained at all times.

The contactors controlling the resistance units are actuated from a 600-volt circuit obtained from a dynamotor on the locomotive, which also furnishes current for lights and air compressor.



ELECTRIC LOCOMOTIVE FOR USE ON BUTTE, ANACONDA & PACIFIC RAILWAY

Current is collected from the line by overhead trolleys of the pantograph type, operated pneumatically and which can be put into service from either engineer's compartment by a hand-operated valve. Each passenger locomotive has 2 collectors and each freight unit one collector. The main switch has a powerful blowout, so that heavy current can be broken, and 3 smaller switches are used, one for each of the 2 heaters and one for the dynamotor circuit.

Protection for the locomotive wiring is secured by a main fuse for the trolley circuit and 2 fuses for the motor circuits, all of copper ribbon type, fitted with hinged covers to facilitate renewals, and located as near as possible to the overhead trolley in order to protect the wiring circuits near the source of supply.

A 2400-volt insulated bus line runs along the center on the roof of the cab, and is connected direct to the pantographs. The bus lines are connected by couplers between the 2 units of the freight locomotive, so that current may be obtained from one or both of the collectors. These bus lines are adequately guarded by railings.

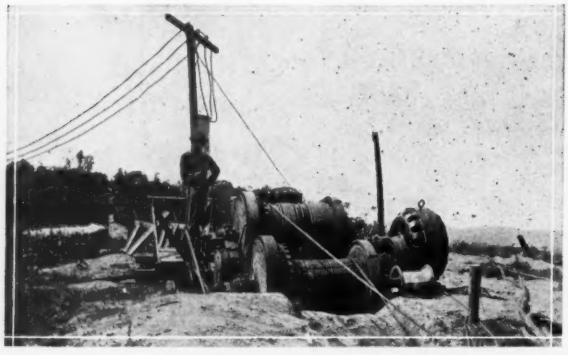
The locomotives are equipped with arc head lights, and in this head light circuit are the gage lights illuminating the ammeter and air gages. Interior lighting of the cab is from incandescent lights arranged in 2 circuits and controlled by switches in the engineer's cab.

To furnish air for the brakes, a compressor of 2-stage, motor-driven type, with piston displacement of 100 cu. ft. of air a minute when pumping against 135 lb. per square inch, is provided. Air is taken through a screen inlet and in passing from the low-pressure to the high-pressure cylinder delivers to 4 air reservoirs, each 12 by 164 in., located under the cab floor, and all connected together.

EXCAVATION BY MOTOR

IN order to remove the worthless soil above a valuable deposit of clay, the Twin City Brick Co., St. Paul, Minn., uses a drag bucket operated by a motor-driven hoist.

The clay deposit forms a bluff above the plant and the bucket is dragged over the surface, removing the soil on its down trip and returning empty. The bucket handles



MOTOR HOIST PLANT FOR WORKING SCRAPER EXCAVATION

about 300 cu. ft. of soil and makes a trip every 2 min. The hoist is a double drum American and is driven by a 75-hp. Westinghouse induction motor.

The use of electric drive is especially effective for such an operation because it enables one man to handle the entire machine, and is easy to relocate.

WORK ON THE STEAM POWER PLANT at Marietta, Ohio, which is being rebuilt by the Parkersburg, Marietta & Inter-Urban Railway Co., is progressing nicely and the company hopes to have it completed and in operation within a short time. The workmen are engaged now in setting the engines and boilers in the plant.

The company is also working on the high tension line between Marietta and Parkersburg, W. Va., and this should be completed and ready for use by September. The final estimates of the work on the water power plant which is to be constructed at Lowell, Ohio, will be in the hands of the men interested in this venture within a short time. The plan is eventually to build several water power plants at different locations on the Muskingum.

MISDIRECTED ENERGY

Stopped Pipe Causes Temporary Shut-Down

By I. H. P.

SEVERAL weeks later the gas-engine pessimist and the night man sat at the desk of the latter in front of the switchboard. It was early in the evening, and the engineer was talking.

"As I was saying, we ran along for some time with very fair success while the work on the foundation for the new unit and the enlargement of the station was going forward. Then gradually a new and strange condition brought itself to our notice, which we could not define, and which came to a climax one Saturday afternoon. This condition seemed to impose a load on the engine, and we had trouble in holding the speed up to normal even on the lighter loads, and why she seemed to labor so we could not determine. Repeated tests showed the gas to be of good quality, the fires were in good condition, there were no hot bearings, and the pistons were not sticking in their bores, else we should have seen and smelled the smoke from the burned oil.

"On this afternoon of which I speak, as the load began to increase, the speed continued to drop, and in spite of all we could do she died at 7:20 p.m., reluctantly, but gracefully. Going into the fireroom to open the air valve and start the pump, I noted that the water-seal pot, into which the gas main between the producers and scrubbers dipped, was empty; its normal condition was full and just running over.

"I knew there were only 2 ways for the water to get out so quickly, first, that an explosion had blown it out, and second, that it had been lifted out and drawn over into the scrubber by the draft.

"As there had been no explosion, I concluded that the latter action had taken place, and the seal-pot being dry, air had been admitted into the main, which of course had killed the engine. Hastily filling the seal-pot with water and turning an inch hose into it, I determined that the performance would not be repeated that night. We soon got the engine turning over again, and it was soon apparent that in order to keep moving at all, it was necessary to keep both throttles wide open, and the air admission valve, controlling the air to the mixing chamber, nearly closed. This led us to believe that there was some obstruction to the flow of gas somewhere in the main, and a hurried examination of the draft gages bore out this theory, the draft at the producers being normal, but that at the wet scrubber was enormous, all the water in the U tube being drawn out in a jiffy as soon as the test cock was opened. The continued rise of water in the scrubber surprised us somewhat, but as there was nothing else to do but keep going, conditions could not be changed. By 9 o'clock we had struck the peak and water had risen in the scrubber to the height of 8 or 9 ft., as near as we could tell. Knocking sounds came from the interior, caused, I suppose, by the large gas bubbles bursting at the surface and throwing the pieces of coke rattling against the sides. The engine underwent enormous labor, as well it might, holding that quantity of water in suspense, the speed being about 75 per cent of normal. As soon as the load began to fall off, the water level fell in the scrubber, and at 11:30 p.m. the usual operating conditions had been resumed.

"The following day being Sunday, the plant was shut down and an investigation at once set on foot. The main was opened at the elbows, and the trouble

was located as indicated by the draft gage. The 10-in. ell into the scrubber was found to be chocked with deposit carried over from the producers, which decreased the working diameter of the pipe by fully one half and which thoroughly explained the behavior of the engine.

"This is a fair sample of some of the fun we have been having. The other unit will be up and ready to run in a few weeks, and will be considerable of a help when it comes to making adjustments on the idle engine.

"Oh! By the way, here is a short resume of the results obtained a few weeks ago by some University students who made quite an exhaustive test. Maybe you would like to look at it."

He handed his listener the paper whereon was written the following:

Size and type of engine—twin, 4-cycle horizontal 250 hp.
Duration of run, 24 hr.
Total output, 1604 kw.-hr.
Total coal fired to producer, 3042 lb.
Scrubber water used per kw.-hr., 0.971 cu. ft.
Jacket water used per kw.-hr., 0.974 cu. ft.
Average suction at producer, 0.441 in. water.
Average suction at wet scrubber, 2.76 in. water.
Average suction at dry scrubber, 3.34 in: water.
Average calorific value of gas, 117 B.t.u.
Average calorific value of coal, 12,525 B.t.u. (By analysis.)
Temp. jacket water at inlet, 51.87 deg F.
Temp. jacket water at outlet, 116.36 deg. F.
Average gas temp. leaving producer, 493.6 deg. F.
Average gas temp. leaving scrubber, 61.73 deg. F.
Coal used per kw.-hr., 1.894 lb.
Cost fuel per kw.-hr. @ $4.50 per T., 0.427 cents.
Cost labor per kw.-hr., 0.462 cents.
Cost fuel and labor per kw.-hr., 0.889 cents.
Thermal efficiency of plant from coal pile to switchboard, 15.34 per cent.

(To be continued.)

BUYING COAL ON THE B.T.U. PLAN

Method of Sampling Employed by the Government

By J. C. Hawkins

THE method of sampling coal to determine the heat value as described by Mr. Kavanagh in the June 15 number is not a correct one, and the chances are the question, "Has the cargo the same heating value as the sample?" is very apt to come up. There are several ways in which coal may be sampled, but the one herein described is about the best, and is used in a certain government department in which coal is purchased on the B. t. u. basis.

Coal used is New River crushed mine-run for use in under-feed stokers, the contract calling for about 3500 long tons per year, delivered in lots of 500 tons. This coal is hauled from the cars in wagons or motor trucks at about 3 tons at a load. It is weighed by the coal inspector at the building, and dumped into the hopper of a coal conveyor. Near the conveyor hopper there is placed a sample bin about 4 ft. high, 4 ft. long by 3 ft. wide, made of heavy matched lumber, and lined with sheet iron. There is a drop door on the front side at the bottom, also a tight fitting cover, both of which are locked. When the truck is dumped into the hopper the inspector takes out a shovelful as a sample, and places it in the bin. This insures a correct sample of the order of coal which could not otherwise be had, for instance if the order calls for 500 tons this would mean about 10 cars, 2 or 3 of which would be of inferior quality such as substituting slack in place of crushed mine-run. Sampling in this manner insures an average sample from all cars.

After the coal has all been hauled, which takes about 3 days, the concrete driveway is swept clean and used as a crushing floor. The sample coal is then crushed. This is done by a home-made crusher consisting of a heavy 18-in. pulley with a 14-in. face having a frame and handle made of pipe and fittings. Several heavy pipe flanges were bolted to the spokes to add weight, also a box is fixed on either end of the shaft which is filled with scrap iron. The crusher is operated by 2 laborers. The drop door of the sample bin is opened, and a layer of coal about 1 or 2 in. deep spread over the floor. Then the crusher is run back and forth over it until it is reduced to about ¼-in. size. It is then put in a pile at one side and another portion crushed, and so on until the full sample which is usually about 400 or 500 lb. is crushed. The pile is then spread out making a flat pile about 2 ft. thick and quartered. The opposite quarters are saved and the other rejected. The quarters saved are again quartered and so on until the remaining sample will go into the can to be sent to the chemist.

These cans are of iron with a locked cover, hold about 50 lb. each, and are furnished by the testing department of the Bureau of Mines. When the cans are filled a notice is sent to the testing department which sends a wagon after the sample. At the same time the chief engineer sends a properly filled form blank to the testing department stating the number of tons which the sample represents, the number stamped on the can containing the sample, and the general conditions of the coal, whether wet, dirty, fine, etc. The weight of the coal is that given by the inspector and not that of the dealer, although the dealer also weighs it on his scales. After the coal is tested the basis for payment is made on the report of the analysis of the sample as compared with the standard guaranteed analysis as stated in the contract. The sample is handled as rapidly as possible to prevent drying out, the work being done by laborers under the supervision of the inspector.

During the winter of 1911-12 the boilers were heavily overloaded, and quite a little trouble was experienced in holding the steam during the peak load.

The coal company was having trouble to furnish coal, and one lot was nearly all slack instead of mine-run, which further augmented the trouble. When the lot was tested it was found to be so poor in quality that the price paid was about 86 per cent of the contract price, which represented a reduction of about $150 on the shipment. This is, I think, the only correct way to sample an order of coal. A shovelful taken in 1 or 2 places is not a true representative sample, and the importance of sampling is so great that much time may be well spent in securing a correct sample, on which there can be no question, and on which analysis can be depended as correct and fair to both the dealer and the buyer.

At Fontanelle, Ia., engineers employed to draw up plans for the city light plant and water plant recently submitted tentative plans to the council. A prospective route for a transmission line from Fontanelle to Greenfield has also been laid out.

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

REPAIRING WATER JACKET ON GAS ENGINE

By B. Lucky

WHERE I am employed we have a 40-hp. gas engine that has the cylinder and water jacket cast together and operates on the hit and miss principle. The water that is circulated through the jacket is taken from a tank on the roof that supplies the whole plant. After the water passes through the jacket it is run into washing tanks about the plant.

One day the pipe fitters shut the water off from the supply tank to make some repairs, not thinking anything about the gas engine, until it began to smoke, then instead of telling the engineer in charge or stopping the engine they turned the water on again. When the cold water reached that hot cylinder it opened up

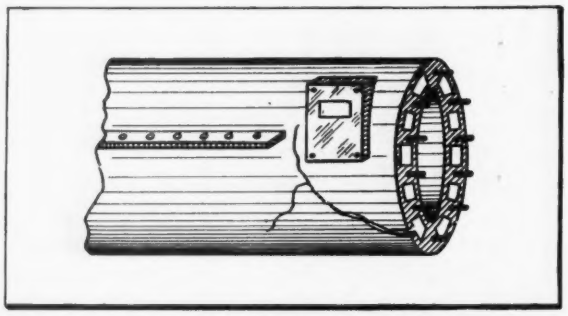


FIG. 1. CRACK IN WATER JACKET

the water jacket in a crack that extended from the top of the exhaust port in a half circle to the cylinder head, as shown in the sketch.

Of course this put the engine out of service and we needed it every minute. So we got busy right away. First, we removed the exhaust valve and piping also the cylinder head, then with a ratchet drill, drilled a 21/32-in. hole through the water jacket and continued into the wall of the cylinder about ¾ in. with a half-inch drill. This was tapped for a ⅝-in stud. The stud was put on the upper side of the crack and with a nut drawn tight, as this side of the cylinder got the hottest and was put on to prevent the crack from spreading any farther, the upper half having risen above the lower half about ⅛ in. This I chipped off until the surface of the crack was even, then with a diamond-pointed chisel followed the crack, cutting a groove about ⅛ in. deep which was filled up with small strips of lead driven in with a small calking tool.

Using a piece of cardboard I made a pattern for a patch to cover the crack. This was cut out of 1/16-in. sheet steel, and was made about 2 in. wide. Along each edge were drilled 3/16-in. holes about one inch apart. After bending and forming the patch to fit the cylinder it was clamped on and used as a templet to drill 5/32-in. holes into the jacket. This was done with a small electric drill, which was borrowed from an automobile plant near by. These holes were tapped for 10-24 machine screws. A thick paste was then made from peroxide of lead or litharge (as it is sometimes called) and glycerine and applied to the crack and patch, which was then screwed down and allowed to set overnight. The next morning the engine was put into service without any leakage.

This experience has taught me a lesson that I think will be a benefit to other engineers; that is, to be sure when piping the water lines to jackets, that there is no chance for the water to drain or siphon entirely out of the jacket, if the supply should be temporarily shut off or stopped from any other cause. Our piping not being arranged that way as soon as the pipe fitters parted the line it took air, and of course, allowed all the water contained in the line to siphon out into the washing tanks. If our piping

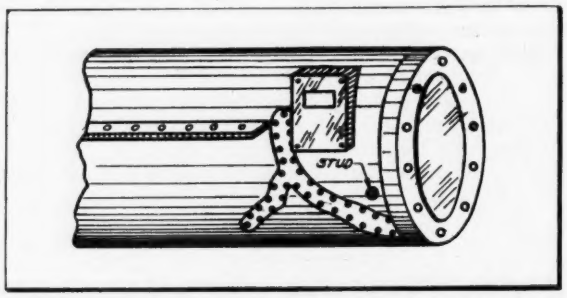


FIG. 2. WATER JACKET AFTER REPAIR WAS MADE

had been arranged properly the jacket would never have cracked as the incoming water would have had its temperature raised by the hot water in the jacket before coming in contact with the walls of the cylinder and jacket. As it is, we are considering ourselves lucky that we have any engine left.

George S. Rice, chief mining engineer of the United States Bureau of Mines has dedicated to public use a patent just issued by the Government for a hoisting cage which is primarily for use in rescue work, but can be used for other purposes.

Mr. Rice in describing his invention states that it has for its object the provision of a novel cage which shall have peculiar advantages in regard to portability and ease of assembling and disassembling. He adds that although not limited to such use it is of especial utility in mine rescue work as an emergency cage.

Recent test of an oil burning boiler as designed with internal furnace, dry back and special Dutch oven extension and patented by John Dick, described on p. 405, of April 15 issue of Practical Engineer, showed a performance of 170 hp. for a boiler rated at 100 hp., and with good economy.

RUNNING OIL ENGINES ON THE MANCHAUG RIVER*

Operating Troubles Encountered During Erection of Building

By C. E. Corning

WHEN first taking charge of the power department, Mr. Curley had felt it necessary to hire a gang of riggers to move the new and old machinery into the new power house. For some weeks, under the leadership of Mr. Muggs, they had been working on the first oil engine at the farther end of the factory grounds; now that a foundation was ready for it, the first section was slowly coming into view and it was soon to be ready to be set up. Ferguson suggested that a man be sent from the engine factory to do the most important part of the work, but Curley objected to this, saying that he would have no trouble in doing the job. Ferguson said that he was not competent to do it. But no sooner had the work of re-assembling the many parts begun than he was asked all sorts of questions as to how this and that went, for he was the only one who knew much about the engines.

Where the principal difficulty came was in lining up the 8 engine bearings and the 2 for the generator, with the shafts in place, and after one or two had tried it a man who had had experience setting up steam engines took a hand and pronounced it all right.

The rings in the pistons were cleaned and all of the valves ground so the engine was in fair shape to start; when Ferguson adjusted the fuel valves and when the air and oil were turned on, the unit ran well for the first start.

It had been the custom to pipe the cooling water, there is a separate pipe leading from each cylinder, to a funnel near the floor, so that the temperature of the water can be easily taken for each cylinder separately. It had also been the custom to run the cold water into the bottom and discharge it from the top; but in this plant it was the practice to reverse this action, which not only required more pipe but made a bad appearance and accomplished no better results. Ferguson was in favor of having the pipes changed so that the water would flow in the opposite direction; the master mechanic, however, thought that 3 pipes were unnecessary, that it was preferable to have each cylinder discharge into a main header running across the top of all of the cylinders. This arrangement was put into effect; it was then necessary to climb to the top of the engine and feel the pipes to determine how the water was being heated.

In building the new power house it was often necessary to run nights and Sundays; in one part plans were made to run all day Sunday and the following night to get a continuous and good piece of concrete. As there were no other engineers who understood the oil engines well enough to run them, it threw a great amount of extra time on Ferguson and his assistant. On a certain Sunday we find them working at repairs to get the plant ready for another week, when about 5 o'clock, the gasket on the high-pressure head of the air compression blew out and Richards set about putting in a new one. Having experimented before with various kinds of gaskets, he concluded that asbestos paper about 3/64 in. thick was the best, as it could not burn out from the heat of the air. It was well that he had renewed this gasket, for the next afternoon the one on the low-pressure cylinder of the other compressor blew out, and as it would take too long to remove the piston rod, a double gasket was put in and cut in different places, which worked all right.

Although the other engine had just been fairly well housed over, it was necessary immediately to begin cutting into it in various places to make way for the forms of the new power house. Since the compressors were in a fair way to be undermined by the excavating for the boiler room, it was decided to move them to the other side of the building and build a lean-to over them. In moving them over the base wall of the new building, one of the machines tried to turn a somersault, which landed it upon its side and sprung the shaft. After being set up in the new spot the compressors were convenient for the operators, who had to climb over the new concrete work every time. There were still more conveniences to come, as they realized one day when a gang of carpenters began to put shores for the roof girders and when they had finished the place looked like a forest of posts; they were placed everywhere around the switchboard, so that it was necessary to crawl through a small space under one of the panels to get at the back of it.

Cold Weather Troubles

WITH the approach of winter, no precautions were taken to protect the piping from freezing and thus trouble resulted. It was no longer a question of scientific operation, but of turning over with regularity, and it was very seldom that something did not require thawing out in the mornings. The air lines that ran out of doors, being laid on the top of the ground and having many pockets, gave much trouble in this respect and as this air was used to force the fuel oil from the large tank to the power house, there was hardly ever time to try to thaw it out; but the valve next to the tank was shut to hold what air was in it and the frozen section was cut out and a new piece put in. If the high-pressure lines froze it was necessary to stop the engine that the frozen pipe supplied.

One day, Richards said to Ferguson: "Do you think that we have a very good way to get our oil up to the plant here?"

"It would be all right if it were laid out properly," replied the chief. "But they were in such a hurry to get some way of getting enough oil up here for 2 engines that they simply threw the pipe down on the ground and connected it up. You have seen how much trouble and bother it has caused us, all of which could have been avoided if the pipes had been buried beneath the frost line. Although compressed air is often used to move oils, in our case here I would install a small triplex pump direct-connected to a motor of about 2 hp. at the tanks, having it low enough that the oil would run to it by gravity and the suction arranged so that any one of the 4 tanks could be emptied. I should place this in a small fireproof house and have the switch controlling it in the engine room. Thus, whenever oil was needed the switch could be thrown; the motor, being small enough to start with the full line voltage, would move the pump so that the oil would come at once. Two advantages would be, that there would be no long air line or tank under pressure to give trouble, as the electric line would hardly ever

*Continued from page 693, July 15 issue.

give any trouble, and if the oil was ever thick and heavy in the pipe in winter the pump would quickly raise sufficient pressure to force it through, while with the air there is a limit to the pressure that may be put on the tank."

Running in Parallel

THE engine company had been putting new governors of a more improved pattern on the engines and these were equipped with an adjustable weight, as many steam engines have to make slight variations in the speed; it was Ferguson's custom to throw in the units on the line in parallel with the other plants with the weights set to keep the speed as low as possible, and by watching the ammeters as the load came on to put them far enough ahead to take all of the load possible and still not allow the speed to raise the frequency above 60 cycles. The master mechanic, after observing this operation for several days, said to the engineer:

"Why do you do that? I should think that the engines ought to take their share of the load without any change being made in the governor."

"They would if the other machines would slow up enough to let them; if they don't we have to come up to keep ahead, as it is essential for economy that we do as much as we can and let the steam engines do what we cannot do and it is very seldom that a number of alternating-current generators will equally divide the load if some adjustment is not made in their speed."

Mr. Curley could not be convinced and quoted steam turbine experiences to bear out his theory, but Ferguson answered:

"In the case of your turbines you had a generator running at 3600 r.p.m. with a continuous pressure behind it, while here we have a generator running at 165 r.p.m. and getting a power stroke every 120 deg., which should make some difference."

Mr. Curley had an assistant, a Mr. Ronds who, like himself, had graduated from a technical school; so they must have some students from a near-by school to make a test on one of the engines with all of the timber work and other building paraphernalia around them, when it would have been much better to have waited until the power house was finished. They came on one of the coldest mornings in the winter and the indicators and reducing motions having been put on the night before, they prepared to take cards, weigh the oil, etc. When the cooling pump was started, there was some delay about getting water, so it was necessary to turn on the town supply. Ferguson repaired to the bank of the pond to investigate and soon had a good fire on the ice around the suction pipe.

Inside, the professor was trying to apply gas engine theory to the oil and it did not seem to work out in practice; then, to make it more interesting, the fuel oil evinced a desire to stop running on account of the low head from the temporary weighing tank. As a consequence, the engine began to throw off her load and finally the test had to be given up while the professor and Mr. Curley tried to locate the trouble in one of the governors, with no result.

When at last the days began to grow warmer, Ferguson and his men welcomed it, for it meant the end of freezing troubles; but there were others in store for them. The crossheads of the air compressors, not being heavy enough for the work, began to break and when 4 had gone that way steel castings were substituted instead of cast iron.

The men began to work on the forms for the concrete roof and before the cement was poured in, it was necessary to wash out the dirt with the fire hose; as most of the paper covering the engine room roof was full of holes, streams of water began to fall on anything that happened to be under them whether it was engines, generators or motors. It was useless to make any complaint to the construction department, for it was a case of every department look out for number one. To vary the monotony, there were showers of dust and flying timbers that sometimes broke through the roof of the compressor shed, but fortunately did no damage. There was no lack of excitement. Once Ferguson and Richards narrowly escaped injury by the fittings in the high-pressure air line bursting, from which fragments flew in all directions. To crown it all, Curley desired to take Richards out to help move in the new engine which the company had purchased, since his gang of riggers had gone to other fields, and he was going to move a piece of machinery weighing 25 tons with a crowd of inexperienced men. Though Ferguson strenuously objected to this move, it went through and one day while running down an incline Richard's foot was caught under one of the rolls and he was laid up so that he was no use to either Curley or Ferguson.

Thus it seemed that in spite of all the operators could do they were in the midst of chaos; for it is doubtful if such machines were ever run under such conditions and although Ferguson had been successful in giving the best service that the company had ever received from its oil engines, most engineers will agree with him in feeling that such a position carried with it too much care for the credit that was gained. As he saw that it would still be a long time before the building would be completed, he informed Mr. Curley of his intention of leaving for the steam engine field and even though he was approached with all sorts of offers from the company, his mind was fully made up that to handle an oil plant it was necessary to have cooperation from all and this was impossible to get there. He could truthfully say that in all of his experiences there were none that could compare to those while running oil engines on the Manchaug River.

WHERE A HARDWOOD FLOOR is required over a concrete slab, the common way is to lay bevelled screeds about 12 or 15 in. on centers, bed these in cinder concrete, over them lay a 1-in. or 2-in. rough floor, and on top of this lay the hardwood, 7/8-in. as a rule. The Aberthaw Construction Co., Boston, has laid an excellent hardwood floor by putting down 7/8-in. form lumber on top of the rough concrete, laid diagonally to the finished floor and on top of this nailing the hardwood. This was done on a government job. However, the boarding is to be laid, the hardwood is much better square edged than tongued and grooved. Where square edged, if the floor boards warp, the edges do not split. If repairs are necessary, a board can be taken out without ruining the floor around it, and it will be found that the boards will wear better when square edged than when grooved.

The boarding should be laid the way of the greatest traffic, that is, trucking should not run at right angles to the floor boards if this can be avoided. When the progress of traffic is definite it will pay to change the direction of the boarding where the turn in traffic comes.

For wet floors the Aberthaw Construction Co. does not use maple. Rift hard pine, which is full of pitch, is very much better. There are preparations sold for preserving wood floors from the effect of wetting. They are quite worth looking into.

CONSTANTS FOR BRAKE HORSEPOWER OF GAS ENGINE

By R. M. Fotheringham

IN figuring the brake horsepower of gas engines, the piston speed and number of cylinders as well as diameter of cylinders must be taken into account, and also the kind of gas used and the efficiency of the machine. The kind of gas will affect the mean effective pressure secured, and the mechanical efficiency will govern the amount of power which is left after the engine itself has been driven.

In the tables found in the data sheets of this issue, the constants C and C^1 have been secured from actual tests on engines in use with natural gas having a heat value of 1000 B.t.u. per cu. ft. For the 4-cycle engine a mean effective pressure of about 77 lb. per sq. in. has been used and the mechanical efficiency of 85 per cent, as these have been found to agree closely with average practice. For the 2-cycle engine a mean effective pressure of 67 lb. has been used, and a mechanical efficiency of 71 per cent, this low mechanical efficiency being taken because of the air pump resistance required to compress the charge which amounts to about 6.5 lb. per sq. in. of cylinder area of the main piston. The values and constants are explained on the data sheets.

To find the brake horsepower for a single-acting, 4-cycle gas engine, multiply the constant C by the piston speed in feet per minute and by the number of cylinders on the engine, the constant being taken for the diameter of cylinder in the engine under consideration. For a 2-cycle engine, the horsepower is found by multiplying the constant C^1 for the given size cylinder by the piston speed in feet per minute and by the number of cylinders on the engine. In either case, if the engine is double acting, the brake horsepower as found should be multiplied by 2.

In case the brake horsepower and the piston speed are known, and it is desired to find the diameter of cylinder required, the process would be to divide the required brake horsepower by the piston speed in feet per minute and the number of cylinders, giving the value of constant C, and opposite this value in the table would be found the corresponding diameter of cylinder. The same process would be carried out for a 2-cycle engine, except that in the table the diameter opposite the value C^1, would be the one required.

The horsepower as calculated by the use of these constants is the normal or rated power, and the engine should be capable of carrying an overload of 15 per cent in excess of this for short periods.

KNOCK IN OIL ENGINE

By J. B. Walker

THE engine in question is a 10-hp. Muncie oil engine. It is a 2-cycle engine with cylinder lying in a horizontal plane.

I first noticed a sharp click in the cylinder, just loud enough to be detected with the ear. It gradually got louder until I thought it time to examine the bearing, etc., inside the cylinder. The pin bearing seemed to be in good condition, but just a little loose according to my ideas. I tightened this bearing just a fraction and replaced piston in engine. The knock was gone and the engine ran as well as could be wished for, about 10 min., then it started in again worse than ever.

The next time I took it out I took up the side play on the pin (about ¼ in.) with lead washers. This did not help in the least. All of the bearings ran cool as could be expected.

Another examination showed that the piston and cylinder were worn so that piston had about twice as much play in the vertical plane as in the horizontal. The piston had been working crosswise in the cylinder, causing the knock. I loosened the pin bearing, as much as I thought it would stand without knocking, so that it would not grip the piston pin when it started up but would allow the piston to slide on bottom of the cylinder because of its own weight. This remedied the trouble and I have heard the click but 2 or 3 times since.

GAS PRODUCER ISOLATED PLANT

Figures from the Colorado School of Mines on Commercial Operation with Emergency Load

By R. S. Hawley

RECENTLY an experiment made at the School of Mines with the gas producer plant has furnished some interesting and instructive data along the line of power costs. While repairs were made by the Golden Illuminating Co. on its substation, arrangements were made to throw the day load to the power plant at the School of Mines.

This could not be considered a complete test and did not prove what the plant is capable of doing, yet it did show the operation under actual conditions of service. The load was carried for 3 days in succession, but for a period of less than 8 hours out of each 24. The load factor was about 40 per cent. These conditions were not favorable to the plant, yet the coal consumption was less than 3 lb. per kw.-hr., based on the total output for the 3 days. A lignite coal, having a calorific value of 10,800 B.t.u., was used.

Seven thousand two hundred gallons of water were used for cylinder cooling, which is a rate of about 350 gal. an hour. At the usual cost of water, 10 cents to 25 cents a thousand gallons, it will be seen that the water supply is a factor to be considered in the installation of a gas producer plant. During this run the cost of water was 60 per cent of the cost of fuel. At full load the engine would require about 8 gal. of water per hp.-hr., at a temperatrue range of 60 deg. to 115 deg. and proportionately more with a temperature range of from 115 deg. to 150 deg. The cost of water could be reduced fully 75 per cent by the installation of a cooling device, by which the water could be cooled and re-used by the engine. The saving in one year under ordinary conditions of operation should pay for the water cooler.

The thermal efficiency of the plant was 10 per cent. Under favorable conditions a thermal efficiency of 15 per cent or more might be expected.—School of Mines Magazine.

The Committee of Management of the International Engineering Congress, 1915, announces that Col. Geo. W. Goethals, Chairman of the Isthmian Canal Commission and Chief Engineer of the Panama Canal, has consented to accept the Honorary Presidency of the Congress and will preside in person over the general sessions to be held in San Francisco, September 20-25, 1915.

FOREIGN DEVELOPMENT IN THE POWER PLANT FIELD

Chemically Pure Iron for Electric Motors

By J. H. Blakey

RECENT attempts to obtain a chemically pure iron by means of electrolysis have been so successful that it is thought that for certain special purposes this form of iron is likely to take the place of steel in the manufacture of electrical machinery. The operation is in practical use in the workshops of the Langbein, Pfanhauser Co., at Leipsic, and is due to M. Fischer. The method consists in producing a pure metal from a salt of iron by electrolysis. Hitherto all attempts in this direction have been of no practical value because of the presence of hydrogen in the product, which had the effect of rendering it porous and of no consistence.

M. Fischer has succeeded in overcoming this difficulty, and an iron can now be produced which is free from hydrogen, and is as light as aluminum. It has greater magnetic permeability; that is, it magnetizes and demagnetizes more easily than ordinary iron, and does not retain any residual magnetism: all of which properties make it valuable for the manufacture of armature plates. In a test recently made of 2 motors of exactly the same size and build, one of which had armature plates of steel and the other of electrolytic iron, it was found that under identical conditions the former developed ½ hp. and the latter 1.3 hp. If these figures are to be relied upon, there can be no question of the value of this new form of iron for electrical construction.

Impermeable Concrete

THE production of an impermeable concrete has occupied the attention of cement men for a long time. At the congress of the International Association for the Testing of Materials held in New York, the report of M. Grittner, of Buda Pest, indicates that the products offered thus far for the impermeableization of cement have not been very satisfactory. Two processes only have been successful: (1) Fluatation, or treatment with fluoric acid; which is costly on account of the time and labor involved. (2) The employment of an 8 per cent solution of potassium soap (black soft-soap) instead of water in the preparation of the concrete, on the condition of using a proportion of at least 300 kg. of cement per cubic meter (500 lb. per cubic yard.)

In the course of the discussion which followed, M. Gary stated that he had made experiments with 20 impermeableizing materials of various kinds. At the beginning the results are often excellent, especially with a mortar containing 5 per cent of potassium soap and 4 or 5 per cent of a heavy oil in emulsion; but always when the water has evaporated the materials lose their efficiency. The only satisfactory method, according to him, is to coat the concrete with several applications of pure cement and then to paint with tar.

In Paris, at the laboratory of the Ecole des Ponts et Chausses, it has been recognized that all the impermeableizing products of commerce, which sometimes give a perfect waterproofing under feeble pressure (a few inches of water), are all useless under strong pressure, and then generally the mortars made with them become more permeable than those which do not contain them.

A concrete with a high proportion of cement, and covered with tar, seems to offer the best solution. The coating of tar should be thin, as being less liable to crack, and the upper face of the concrete should be of a rich mixture, if not pure cement, as the tar will not form a water-tight coating on a thin concrete.

Transformation of Sunlight into Electrical Energy

IN the Zeits. fur Elektrothermie, M. C. Winther describes his photopile, which is an instrument for the transformation of the energy of sunlight into electricity. The inventor, having established the fact that the ultra-violet rays of sunlight effect certain chemical reactions, as the oxidation, for instance, of a solution of ferrous oxalate in the presence of air, conceived the idea of storing the energy of the ultra-violet rays by making them perform a chemical transformation which later could be utilized for the production of electrical energy. The cycle of operations consists, so to speak, in creating by means of the energy of the sunlight, a chemical construction which on being destroyed gives back the energy required to produce it, in another form. The chemicals used are an aqueous solution of ferrous chloride and mercuric chloride, which when exposed to the ultra-violet rays are changed into ferric chloride and mercurous chloride, according to the following formula:

$Fe\ Cl_2 + Hg\ Cl_2 + \text{luminous energy} = Fe\ Cl_3 + Hg\ Cl$

which is a combination that remains stable at temperatures below 40 deg. C. or 104 deg. F. If at a temperature below 40 deg. C. electrodes are introduced into the solution, there results immediately the production of a current of electricity which continues until the complete reproduction of the original constituents. As the temperature affects the intensity of the current it is possible to get electrical energy in usable quantities, a result which has never before been attained with the photopiles previously in use.

Unfortunately the solar spectrum is not very rich in the ultra-violet rays which serve as an intermediary in this transformation. It may be discovered, however, that there are other rays having this property, and also it is possible that other elements may be used, in which the chemical action will be greater than in those chosen by M. Winther. In any case, the inventor of this new photopile has great hopes of being able to produce an electrical current which will be suitable for industrial purposes.

ARRANGEMENTS ARE GOING FORWARD rapidly for the National Gas Power Show of the National Gas Engine Association, to be held in Kansas City, Mo., August 16 to 23. A special train will leave Chicago at 6 o'clock on August 15, from the Santa Fe Railroad, arriving in Kansas City on the morning of the 16.

Special days have been arranged at the show, as follows: Opening night, Saturday the 16, 7 p.m., Monday the 18, Commercial Day; Tuesday the 19, Tractor Day; Wednesday the 20, Ladies' Day; Thursday the 21, Dealers' Day; Friday the 22, Farmers' Day; Saturday the 23, Get-Together Day. Over 100 exhibits are assured, and short talks will be given each day from 2 to 3 p.m., on subjects pertaining to gas engines. H. R. Brate, Secretary of the Association, whose address is The Coates House, Kansas City, Mo., will make hotel reservations for those who wish it, and who specify the kind of room desired and the amount to be paid.

POWER PLANT CHEMISTRY

Care of Flue Gas Analysis Instrument

WHEN a piece of work has been done it is always interesting to look it over and see where an improvement, if any, could have been made. It is just so with the burning of fuel. The fact that it burned and produced sufficient steam to do the required work is no indication that conditions were such that the greatest amount of heat possible was transferred to the water, nor that all the combustible matter in the coal was properly oxidized. Analysis of flue gases is the most convenient and exact means we have at present of determining whether the furnace conditions are right and whether combustion is complete.

To secure accurate results, great care should be exercised in taking the sample of flue gas to be analyzed. It is generally conceded that the proper place to secure the sample is just as the gases leave the heating surface of the boiler for the stack. At this point combustion should be completed, for if it is not it will be of no further value in producing steam in the boiler. Any further along in the breeching is liable to error due to leaks that are apt to be present at the damper and in the breeching.

The sampling tube inserted into the gas space should be of glass or porcelain as the action of the gases on metal may cause considerable error in the results of the gas analysis, and the tube should extend sufficiently into the gas space to avoid any stratification. Methods employed for drawing the gas from the flue depend somewhat upon the instrument used for making the analysis.

Where the gas is to be analyzed immediately and in the boiler room, a rubber bulb pump serves very nicely. In cases where a sample is to be collected extending over a period of time for analysis at another time or place, some form of automatic pump is desirable such as a jet or fall pump. Where the analysis is to be made immediately, some means should be provided to cool the gas down to the temperature of the room before the analysis is started.

For power plant operation the Hays gas analysis instrument is used extensively, and, while not so accurate as some used in exact tests of a plant, it is easily handled and convenient for carrying about. For checking up combustion in daily operation, the instrument is sufficiently accurate and the test can be made rapidly.

The principle of operation is to measure the gas; then by passing it into contact with a solution of strong caustic potash, which absorbs the CO_2, and measuring the remaining gas, we are able to determine the percentage of CO_2. Passing the remainder into an alkaline pyrogallol solution, removes the oxygen; then in a similar manner the CO is removed by an ammoniacal cuprous chloride solution. This method is the same as employed in the Orsat apparatus and the detailed directions which follow are applicable in a general way to the Orsat as well as the Hays.

Operating Instructions for Gas Analysis Instrument

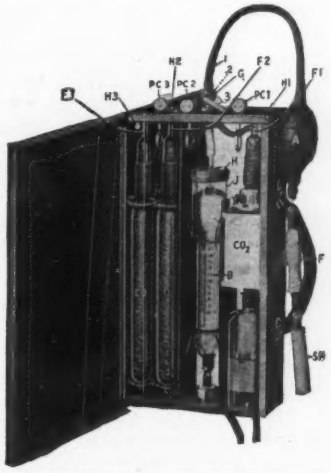
CLAMPS, PC1, 2 and 3 will be set on the tubes when the instrument arrives. Continued pressure will flatten the tubes. When the instrument is not in use, hang it on a nail, using the hole, H3. Slip clamps off tubes by springing open and pulling up. Reset clamps before taking instrument down, as the chemicals will flow into B, and necessitate washing the latter out thoroughly.

Gas mixtures are analyzed by the volumetric method, i.e., the quantity of gas called for by the burette B, is taken and carefully measured. The CO_2, O and CO are then removed in turn by absorption, the gas residue being measured in each case and a reading taken.

Volume of a gas is affected by both temperatures and pressures. Gases expand and contract with heat and cold and with changes of pressures. On this account it is necessary that all measurements applied to any gas sample should be taken under like conditions of temperature and pressure. For the purpose of regulating the temperatures, the burette B, in which the gas is measured, is water-jacketed. For the purpose of passing the gas back and forth between the burette and absorption vessels, the leveling bottle L, is employed.

Remove the rubber hood H, and fill jacket J, with distilled water if available. Clear water must be used in any event.

Fill L about ⅔ full of clear water and add about a teaspoonful of some acid. The acid, like distilled



HAYS IMPROVED GAS ANALYSIS INSTRUMENT

water, is not strictly necessary, but its use is recommended for precautionary reasons which will be explained later.

Set the clamps PC1, PC2, and PC3 on the rubber tubes. This is accomplished by squeezing the clamps open and pushing downwards, at the same time supporting the rubber tube on the underside with the fingers.

A bottle containing caustic potash sticks is filled with water and shaken until the sticks are dissolved, making a 5 per cent solution. Set the bottle aside to cool.

Remove the glass plug from the air vent into CO_2 chamber, also the stopper from L. Place these in the instrument case under the burette or you may mislay them.

Insert the glass filling funnel in the hole H1, and connect with filling tube.

Remove the leveling bottle from its compartment and hold in the left hand. With the right hand set the lever handle of cock G in a vertical position. Raise the bottle and water will flow from it through the connecting tube into the burette, driving out the air from the latter through the air vent in the cock G. Raise the bottle until the water pinches out in the capillary tube at the top of the bulb. This locks the burette and holds the water in the capillary tube.

Pour about 3⅓ ounces of the cooled potash solution in the beaker furnished with the instrument. Fill the funnel from the beaker and squeeze the clamp (PC1) open. The water in the burette will fall and pull the potash down into the CO_2 chamber. It will be necessary to raise the water to the top of the burette several times in order to get all of the potash into its compartment.

Watch the glass tube, F1, at the top of the CO_2 chamber. The potash must be drawn up into the curved capillary tube, but must not be drawn over into B. The potash will reach the capillary tube before you have introduced the 3⅓ ounces. To get the remainder into the chamber, force a little air over upon the potash from the burette. To do this squeeze the clamp open and raise L. This will cause the level of the potash to fall in the CO_2 chamber and air will be bubbled out through the solution in the funnel. You will now be able to introduce the remainder of the potash solution.

If, at any time after the instrument has been put in use, you are unable to raise the potash into the capillary tube, it will be evidence that some of the solution has been lost, either through the air vent or into the burette. There should be enough potash in the chamber to form a seal, otherwise air will be drawn through and will bubble up into the glass tube F1. When this occurs it is necessary to add a little potash or a little water.

The determination of CO_2 including the time taken to draw the gas, can be made in 45 sec. The oxygen and CO absorptions require about 5 min. each.

To charge the instrument with the oxygen absorber, proceed as follows: Disconnect the rubber tube from the nipple of the displacement tube at the rear of O. The nipples of the O and CO tubes are rubber-connected by means of a glass tee with a rubber expansion bag. Attach a piece of rubber tubing about 12 in. long to the glass nipple and insert the tubing in the bottle of pyro solution, well below the surface of the liquid. Then, by means of the leveling bottle, draw the pyro solution into the O tube until it rises to the capillary tube at the top. Enough solution should be introduced to completely fill the central tube and form a seal about the bottom of it. Proceed in exactly the same manner to charge the CO tube with the cuprous solution. You will, of course, use the clamp PC2 when working on the O tube, and PC3 when working on the CO tube.

Be sure and keep the bottles containing the O and CO solutions tightly stoppered as the solutions lose strength very rapidly when exposed to air. The pyro solution is affected by light. Keep the bottle wrapped in dark paper.

To empty the instrument of stale solutions, proceed as follows: First, pass air from the burette into the absorption tube or chamber. Next, make the connections as in filling, i.e., if emptying the potash chamber, connect the filling funnel. If emptying the O or CO tube, attach a rubber tube to the nipple of the displacement tube. Invert the instrument and if liquid does not run out, put the lever of the cock in the vertical position, and open the pinch clamp. This will permit air to enter and the liquid will flow out.

In the next article on this subject the steps taken in analyzing a sample of the gas will be given in detail.

DEVELOPMENT OF POWER PLANT

At the Riverside & Dan River Cotton Mills

RAPID growth in the last 10 yr. of the Dan River branch of these mills at Danville, Virginia, from a plant of 43,000 spindles to one of 208,000 spindles has, of course, necessitated large and frequent additions to the power plant. The engineering work for the development of this property has been in the hands of Lockwood, Greene & Co., of Boston.

The first mill was supplied with power from a hydro-electric plant which the company developed on the Dan River a half mile from the mill. When the No. 2 mill was built in 1906 a steam power plant was erected and an 1875 k.v.a. Allis-Chalmers turbo-alternator installed. The increase of power demanded by the erection of the No. 3 mill, with its 48,640 spindles, was met by putting in a 4400 k.v.a. Westinghouse turbo-alternator. The present installation of a 4400 k.v.a. Allis-Chalmers turbine will supply the new No. 4 mill, with its equipment of 73,440 spindles and 2200 looms. All of these generators operate in parallel with the hydro-electric station.

The first boiler plant supplied steam for heating and manufacturing purposes only, and consisted of 6 200-hp., horizontal, return-tubular boilers operating at 100-lb. pressure. As the various turbines were added, the boiler plant was increased, first, by the installation of 3 362-hp. Stirling boilers; second, by 8 542-hp. Edge Moor boilers. The boilers now being installed are 2 746-hp. Edge Moors. All of these boilers with the exception of the original 6 are built for 175 lb. working pressure and are equipped with Foster superheaters.

Advantage is being taken of the construction incident to the present enlargement of the power plant to provide a more economical system of coal handling apparatus, installed by the Guarantee Construction Co., of New York City. An overhead bunker will be built of concrete and steel with a storage capacity of 1500 tons to supply the boilers by gravity. From the cars received on the trestle in the yard, the coal passes through a crusher and is then elevated to the pocket by means of a bucket conveyor.

This conveyor discharges onto a continuous belt equipped with an automatic dumping device which makes it possible to secure an even distribution of coal throughout the entire length of the bunker. From the bunker, the coal is drawn into a motor-driven weighing hopper running on a track throughout the length of the boiler house. The carriage is provided with a cab for an operator who records the weight of the coal as he draws it from the bunker, and then runs his carriage to the hopper of any stoker which needs filling. The Taylor stokers then deliver the coal to the grate.

Underneath the boiler room is a basement for the accommodation of the air ducts supplying the stokers and a system of suction piping by which the ashes are removed from the furnaces to an ash hopper in the yard.

WITH THE SLIDE RULE

In Finding Pulley Diameters, Gear Transmissions, Belt Sizes and the Like

By H. L. Sherman

PROBLEMS relating to pulleys, gears and belts are frequently put up to the engineer and in the following article will be shown how the slide rule can be used to advantage.

In such work it is convenient to have the relations of the factors expressed by means of formulas, which may be translated into rules if desired. Let us adopt as symbols R, the revolutions per minute of the driving pulley; r, the revolutions of the driven pulley; D, the diameter of the driving pulley, and d, the diameter of the driven pulley. Then we have the expression for these different formulas, as follows:

$r = D \times R \div d$; 1.
$d = D \times R \div r$; 2.
$D = d \times r \div R$; 3.
$R = d \times r \div D$. 4.

When put into the form of a rule, the first of these reads, the speed of the driven pulley is equal to the diameter of the driving pulley times its speed divided by the diameter of the driven pulley. The other expressions can be translated in the same way, but the formulas are much more convenient and quite as easy to use.

As a first example, suppose that the driving pulley is 24 in. in diameter, and running at 72 r.p.m., and the driven pulley 18 in. in diameter, what would be its speed? Then we multiply 24 by 72 and divide by 18, as is shown in the arithmetical work. The operation is comparatively simple by arithmetic, but is still quicker and easier by using the slide rule. Using the lower scales, we set 18 on the slide at 24 on the lower scale, and put the runner to 72 on the slide and under the line find 96 on the lower scale, which is 96 r.p.m.

If now we wish to make a change in speed, keeping our driver as before, and want to know what size driven pulley to adopt, we would have our driving pulley 24 in. in diameter, the revolutions 72, and we wish to change the speed of the driven shaft to 108 r.p.m. What diameter of the driven pulley must be used in that case?

From the second formula we have, multiply the speed and diameter of the driving pulley, and divide by the speed of the driven, or $24 \times 72 \div 108$, as shown in the arithmetical work. Using the lower scales on the slide rule, we bring 108 over 24, and bring the runner to 72, which in this case necessitates changing ends on the slide and we find the answer to be 16 in., the diameter of driven pulley.

If, on the other hand, we have our driven shaft, speed and pulley diameter as in the first problem, and wish to speed up the driving pulley in order to get more power from the engine, what diameter of driving pulley would be required with the driving shaft running at 80 r.p.m.

From the third formula we would have the diameter of the driven 18 times its speed 96, and divided by 80, the speed of the driver. Using the lower scales on the rule, we would set 80 on C, over 18 on D, and bring the runner to 96 on C, which gives us 21.6 in. on C, the diameter of the driving pulley to use. This would in practice be made 21⅝ in.

Again suppose that we wish to keep our pulleys as in the first problem, and to get a speed of 116 r.p.m. on the driven shaft, at what speed must the driving shaft run to accomplish this? Here the fourth formula is to be used and we multiply the diameter and speed of the driven pulley, and divide by the diameter of the driver; in this case we have $18 \times 116 \div 24$, as shown in the arithmetical work, and using the slide rule on the lower scales, we set 24 on the slide over 18 on the lower scale, and must bring the runner to 116 on the C scale. This involves changing ends of the slide. And we find that the speed of the driver must be increased to 87 r.p.m.

(A) $\frac{24 \times 72}{18} = 96$ r.p.m.

(B) $\frac{24 \times 72}{108} = 16$ in.

(C) $\frac{18 \times 96}{80} = 21.6$ in.

(D) $\frac{18 \times 116}{24} = 87$ r.p.m.

(E) $\frac{5.5 \times 850}{26} \times \frac{15}{73} = 37$ r.p.m.

(F) $\frac{60 \times 120 \times 8}{2750} = 20.95$ hp

(G) $\frac{60 \times 120 \times 8}{1925} = 29.9$ hp

(H) $\frac{2750 \times 24}{60 \times 120} = 9.6$ in.

(I) $\frac{1925 \times 42}{60 \times 120} = 11.2$ in.

(J) $\frac{2750 \times 24}{8 \times 120} = 68.8$ in.

(K) $\frac{1925 \times 42}{120 \times 8} = 84.1$ in.

(L) $\frac{2750 \times 22}{8 \times 60} = 126$ r.p.m

(M) $\frac{1925 \times 40}{8 \times 60} = 160.5$ r.p.m.

ARITHMETICAL EXPRESSION OF THE WORK ON PROBLEMS, ARRANGED AS USED FOR SLIDE RULE WORKING

The formulas given apply to gears as well as to pulleys, and we may, of course, take up a more complicated problem, involving the use of both pulleys and gears. A motor running at 850 r.p.m. has a 5.5-in. pulley, from which a belt runs to a 26-in. pulley on a shaft. This shaft carries a pinion with 15 teeth, driving another shaft by a gear having 73 teeth. What is the speed of the last shaft?

In gears which mesh together, the diameters are in proportion to the number of teeth, so that we may use the number of teeth exactly as we would the diameter of pulleys in calculating speed. If we took this up as 2 separate calculations, we should have first to find the speed of the driven shaft which carries the pinion, and we would then have $850 \times 5.5 \div 26$. We should have to multiply this speed by the number of teeth on the pinion, and divide by the number of teeth on the gear; which would give us the answer as found from the first calculation, multiplied by 15 and divided by 73. This may all be combined into a single expression, as shown on the arithmetical work for example E, and we can perform the operations on the slide rule as follows: Using the lower scales, for accuracy, we set 26 on the slide over 55 on scale D, then bring the runner to 85 on the slide; then bring 73 on the slide to the runner, and carry the runner to 15 on the slide; under the runner on scale D we find 37 r.p.m. As a matter of saving of operations let us see how it would work to change the order of our work on the slide rule. As it was carried out, it involved changing ends on the slide twice. If we start by dividing 55 by 26, we can take account of the fact that 15 is in the numerator of the expression, and set the runner to it at once; next, we bring the 73 on the slide to the runner and can carry the runner at once to 85 on the slide, and under the runner we shall find on scale D 37 as before. By this method of selecting our factors according to the position on the slide, we have saved 2 motions in the use of the slide rule, with a consequent saving in time and less chance for errors in setting. This is an important point to study in using the rule, and one which becomes a matter of second nature as one becomes familiar with the rule and its operation.

Power and Dimensions of Belting

IN figuring the power which a belt will transmit, the wider it is, the greater load it will pull, and the faster it runs the more power it will transmit; that is, the factors of power in a belt are width and belt speed; and also the friction between the belt and the pulley which is dependent on the tension of the belt. There is a tension of belt, however, which will give the best results, taking into account life of the belt and the friction on the bearings, and this friction is figured at so much per square inch of section, or for a given thickness of belt, at so much per inch of width, so that the power which the belt can pull may be reduced to the 2 factors, width and belt speed. The belt speed depends, of course, on the diameter of the pulley and the revolutions per minute.

As in the case of pulleys, we may well assume different rules for different problems, in order to be able to reduce our rules to convenient formulas. Let us use D as the diameter of the pulley, N as the r.p.m., W as the width of double belt in inches, w as the width of single belt in inches, and h the horsepower that can be transmitted by the belt. We then have, as commonly used expressions in regard to the belting, the following:

$h = D \times N \times w \div 2750$ for single belt;	1.
$h = D \times N \times W \div 1925$ for double belt;	2.
$w = 2750 \times h \div (D \times N)$ for single belt;	3.
$W = 1925 \times h \div (D \times N)$ for double belt;	4.
$D = 2750 \times h \div (w \times N)$ for single belt;	5.
$D = 1925 \times h \div (W \times N)$ for double belt;	6.
$N = 2750 \times h \div (w \times D)$ for single belt;	7.
$N = 1925 \times h \div (W \times D)$ for double belt.	8.

It should be understood that these expressions as given, are not exact according to the latest belt data, but are approximate and sufficiently accurate for most purposes.

Taking as a first example, what horsepower would be transmitted by an 8-in. single belt running on a 60-in. pulley at 120 r.p.m.? From our first formula we would have, $60 \times 120 \times 8 \div 2750$, as shown in the arithmetical work, and performing this operation on the slide rule, we would find the answer to be, 20.95 hp. As the method of performing these operations is exactly the same as those given in detail for pulleys, it is not deemed necessary to give the method of operation of the rule for each problem.

Suppose now that we use an 8-in. double belt, in place of the 8-in. single belt, what horsepower can be transmitted? Using the second formula, we would have, $60 \times 120 \times 8 \div 1925$, which works out to 29.9 hp.

Taking the transmission of the first example, suppose that it is necessary to transmit 24 hp. instead of 21, what width of single belt must be used? Using the third formula we have, $2750 \times 24 \div (60 \times 120)$ we get by working this problem, 9.16 in. as the width required.

In the second problem, suppose that we find 42 hp. is to be transmitted instead of 30, what width double belt will be necessary? Here using the fourth formula, we have, $1925 \times 42 \div (8 \times 60)$, and this works out to 11.2 in.

If in our transmission, in order to get the 24 hp., we decide to increase the diameter of the pulley, what size pulley would be needed? Here using the fifth formula we find, that we have $2750 \times 24 \div (8 \times 120)$, and this works out to 68.8 in.

Again if in the second case, we decide to get the 42 hp. by changing the speed of the pulley, what size pulley would be required? Here we find that from the sixth formula $1925 \times 42 \div (120 \times 8)$, works out to 84.1 in., the diameter of the pulley.

In the case of the first transmission if the horsepower to be transmitted is increased to 22, how much would the speed of the pulley have to be increased? Here using the seventh expression, we find $2750 \times 22 \div (8 \times 60)$, which works out to 126 r.p.m.

Again, if with the double belt we wanted to get 40 hp. instead of the 30 which could be transmitted at 120 r.p.m., what would the speed of the pulley be? From the eighth expression we have, $1925 \times 40 \div (8 \times 60)$, and this works out to 160.5 r.p.m.

In all computations the figures used are comparatively simple in order to make the principle as easy to understand as possible. It will be found, of course, that where the figures involved are more complicated, the use of the slide rule will be a still greater saving over arithmetical computations than in the problems as given.

SPITE OF THE FACT that during 1912 the production of petroleum increased by 2,000,000 barrels, the demand for petroleum products was so great that the stock on hand decreased from 138,000,000 barrels at the beginning of 1912, to 125,000,000 barrels at the end of the year.

The condition is one which seems to point to a continued rise in the price of petroleum and its products, particularly gasoline, and seems to indicate that within a comparatively short time only the byproducts of petroleum will be available for a power fuel in any large amount.

A SYNDICATE WILL ERECT a light and power plant on property owned by it at Trenton, N. J. Plans will be started in the near future.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

EFFECT OF CHANGING A FEED PIPE; CURING A HOT BEARING

FROM the various ways we find feed pipes disposed in the shells of horizontal return-tubular boilers, it is evident that there is a difference of opinion as to the point at which the feed water should be introduced into the boiler.

Recently a case came to my notice, which was a new one to me. The feed pipe entered the front and was extended back toward the back head, a distance equal to about ⅔ the length of the boiler shell, then by means of elbows was led across to the center of the upper row of tubes. At this point the feed pipe was led back toward the front head. The end of the pipe was given

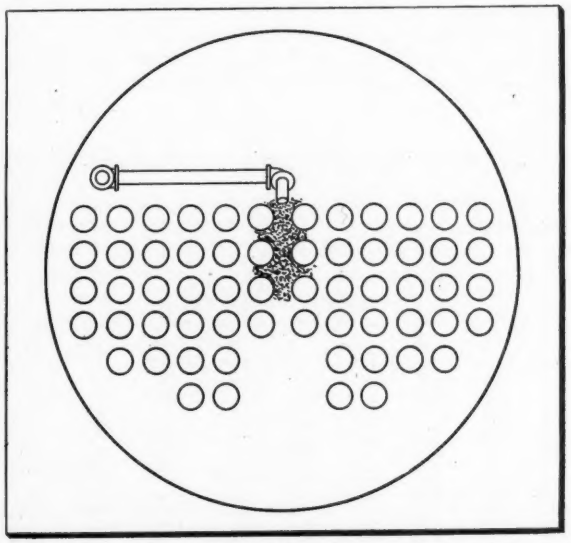


FIG. 2. SCALE FORMATION DUE TO POOR PIPING ARRANGEMENT

a slant so that the feed water was discharged between the upper row of tubes about 2 ft. from the manhole. This arrangement of piping is shown in Fig. 1.

Figure 2 shows the results of such a method of piping.

When this boiler was opened for inspection it was found that the upper rows of tubes at the point where the feed water was discharged were completely bridged across as shown in Fig. 2. Some scale was found on other parts of the inside of the boiler, but no more than we usually find in good practice. As a remedy, the feed pipe was changed so that the feed water was discharged at a point 2 ft. from the back head.

The new arrangement of piping is shown in Fig. 3, the end of the feed pipe is led straight down between the tubes to a point where there is no danger of a deposit like that shown in Fig. 2. After this change was made, very little deposit was found in the boiler when inspected periodically.

Where a central space is provided as shown in Fig. 3 the feed pipe can be arranged as shown with one outlet, but in cases where the tubes are equally spaced throughout, 2 branches can be taken off the feed pipe and

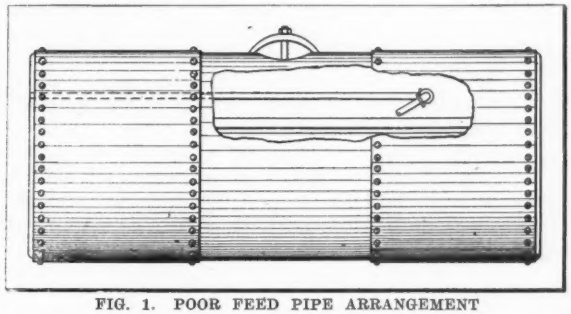


FIG. 1. POOR FEED PIPE ARRANGEMENT

led down between the 2 outside rows of tubes. I have used this last method in several cases with good results.

When locating feed pipes in this way it is well to keep far enough from the back head in order that the feed water will not discharge directly at the point where

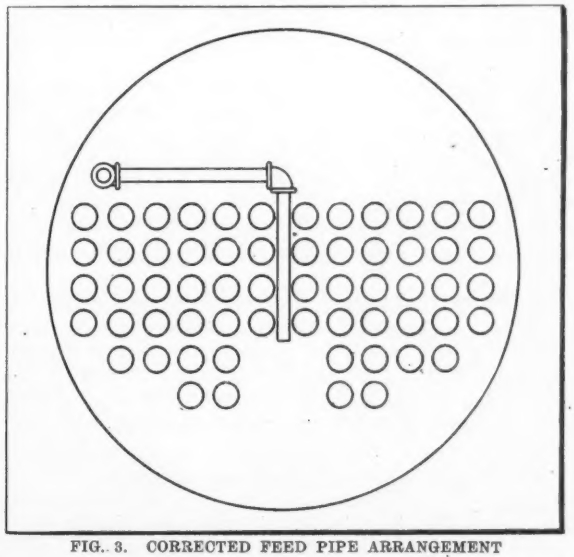


FIG. 3. CORRECTED FEED PIPE ARRANGEMENT

the blowoff pipe is screwed into the shell, for in such a case a leak might be the result.

On page 462, May 1 issue of Practical Engineer, a correspondent gives a short but interesting account of how he cured the hot engine bearings.

Many such cases happen every day and if they were sent to engineering papers along with the remedy they would make interesting and instructive reading.

One morning the night engineer reported that the crankpin bearing of a large ammonia compressor was running hot. Every means at hand was used to cool the bearing, with no effect.

The compressor was stopped to examine the bearing, which was found in a bad state, and the surface of the crankpin was badly cut. This crankpin was oiled with a center oiler which is one of the best oiling devices for this purpose.

Upon examination it was found that the tube which conducts the oil from the oil cup into the hollow ball screwed onto the end of the oil pipe had dropped out. The oil simply ran down the support of the oil cup into the pan underneath the crankpin bearing.

Under these conditions the crankpin had been getting little oil if any.

The pin was smoothed off and the 2 halves of the bearing were scraped, but with no better results.

Finally, we concluded to rebabbit the bearing to see if this would overcome the heating. While the 2 halves of the bearing were being rebabbited this crankpin was smoothed off with files and emery cloth. When calipered the pin measured the same at all points.

The bearings were scraped to a nice fit, and when the job was completed we could see no reason why the bearing should not run cool.

After the compressor had been running for about 15 min. the pin showed signs of heating, and with a continuous stream of oil running into the bearing, continued to heat until the compressor had to be shut down in order to allow the pin to cool.

The bearings were given another scraping with no better results.

It was necessary that this compressor be kept in operation most of the time, which made the situation more uncomfortable.

After trying all means we had at hand, we sent to a local oil works for a gallon of castor oil, such as is used for mechanical purposes. This oil was regulated to 3 drops a minute and in 2 hr. the crankpin was running perfectly cool. We kept the castor oil feeding into the bearing all that night.

The next day we tried the oil ordinarily used on this bearing, with the result that the heating again appeared.

Without allowing the pin to become too hot we again resorted to the castor oil. This time the pin was kept lubricated with the castor oil for a period of 48 hr. When we again went back to the ordinary oil we had no further trouble from overheating. The oil we ordinarily used was listed as engine oil and was of a fair quality.

In this case, of course, the trouble was caused by the negligence of the night engineer and in no way could it be laid to the quality of the oil, for it was used upon all of the engine bearings throughout the plant. The point that I wish to bring out is that castor oil may cure some very bad cases after all other means at hand have failed.

W. S.

WATER IN THE CYLINDER

AFTER it was all over and we had the broken crank and bent connecting rod in the express car, I dug out the following facts:

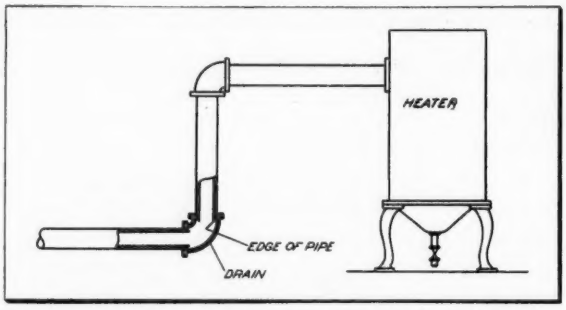
The engineer had started up in the evening (no day run) and the engine was cold. She started too fast to suit him and he closed the throttle. She turned over again, a crash came and he could tell me no more. That night on the way to the shops I reasoned that the drain on the exhaust being ½-in. was not big enough to carry away the condensed water quickly. When he closed the throttle a heavy condensation took place in the cylinder and sucked water back and, when the compression started, caused the wreck.

If someone has another explanation I should like to hear it.

A. J. W.

ACCIDENTAL OIL SEPARATOR

WHEN I took charge of the present plant, there was no drain on the exhaust. The engine is a 14 by 30 Corliss with 5-in. exhaust, which rises with an elbow about 4 ft. before going into an open heater. I was very busy at the time, so put a ratchet under the lower elbow and drilled a ½-in. hole in it, thinking to do a better job later.



ELBOW IN EXHAUST PIPE WHICH ACTS AS OIL SEPARATOR

After I had cleaned the heater and other jobs and commenced to have time, I noticed an accumulation of oil near this hole. I thought I would leave "good enough" alone. Since that I have found no oil in my heater. I believe the sharp edge of the pipe, left by the cutter, combined with the turn, does the trick.

A. J. W.

RELATIONS OF VICOSIMETER READINGS

IN the May 15 issue of Practical Engineer there appeared an inquiry for a comparative table covering the various viscosimeters and in this connection the following table will be found to cover the matter.

At 70 deg. F. Temperature.

Saybolt at 70°F.	Redwood at 70°F	Engler at 20°C.	Saybolt at 70°F	Redwood at 70°F	Engler at 20°C.	Saybolt at 70°F	Redwood at 70°F	Engler at 20°C
50	84	2.5	170	287	8.7	290	490	14.7
55	93	2.8	175	296	9.	295	497	15.
60	101	3.	180	304	9.2	300	507	15.2
65	110	3.3	185	313	9.4	305	515	15.5
70	118	3.6	190	321	9.7	310	524	15.8
75	127	3.9	195	330	10.	315	532	16.1
80	135	4.1	200	338	10.2	320	543	16.3
85	144	4.4	205	346	10.4	325	551	16.6
90	152	4.6	210	355	10.7	330	558	16.8
95	161	5.	215	364	11.	335	566	17.
100	169	5.1	220	372	11.2	340	574	17.2
105	177	5.4	225	381	11.4	345	582	17.4
110	186	5.6	230	390	11.7	350	590	17.7
115	194	6.	235	398	12.	355	599	18.
120	203	6.2	240	406	12.2	360	608	18.2
125	211	6.4	245	414	12.4	365	614	18.4
130	220	6.6	250	422	12.7	370	622	18.7
135	228	6.9	255	431	13.	375	630	19.
140	237	7.2	260	439	13.2	380	639	19.2
145	245	7.4	265	447	13.5	385	649	19.5
150	253	7.7	270	455	13.7	390	659	20.
155	262	8.	275	464	14.	395	668	20.2
160	270	8.2	280	472	14.2	400	676	20.5
165	279	8.4	285	481	14.4	...	...	....

At 212 deg. F. Temperature.

Saybolt at 212°F.	Redwood at 212°F.	Engler at 50°C.	Saybolt at 212°F	Redwood at 212°F.	Engler at 50°C.	Saybolt at 212°F.	Redwood at 212°F.	Engler at 50°C
50	40	1.7	135	109	45.7	220	176	89.9
55	44	4.1	140	112	48.3	225	181	92.8
60	48	6.5	145	117	51.	230	184	95.1
65	52	8.9	150	119	53.1	235	188	97.7
70	56	11.3	155	124	56.	240	193	100.3
75	60	13.7	160	128	58.7	245	196	103.
80	64	17.4	165	133	61.5	250	201	105.5
85	68	20.	170	136	63.9	255	204	108.1
90	73	22.6	175	141	66.5	260	208	110.5
95	77	25.	180	144	69.1	265	213	113.3
100	80	28.	185	148	71.7	270	216	116.
105	84	29.9	190	153	74.	275	219	118.1
110	89	32.	195	156	77.	280	224	120.9
115	92	35.2	200	161	80.1	285	228	123.9
120	95	37.7	205	164	82.1	290	230	127.
125	100	40.5	210	165	84.7	295	232	130.
130	104	43.	215	172	87.3	300	235	133.9

This table has been calculated by C. Watson Gray, F. I. C., Liverpool. The figures relate to Pennsylvania oil of average quality and will not be strictly correct for oil from other sources, especially at higher temperature.

It will be noted that the Tagliabue viscosimeter, not only extensively used in this country but throughout the world, does not appear in the foregoing table but this is explained by the fact that the Saybolt figures will also serve for the Tagliabue instrument. The readings obtained by means of these 2 instruments are practically identical, if care is used by the operator in having all of the conditions alike in each case, as the 2 machines are of the same type, but of slightly different form, and the Tagliabue follows the Saybolt viscosity standard. C. J. Tagliabue.

BARREL EMPTYING DEVICE

IN a great many engine rooms and power plants having compressed air conveniently at hand, the writer has seen valve, cylinder and other oils transferred from the shipping barrels into the storage tanks by wasteful and laborious methods. Figure 1 is descriptive of a simply constructed device for quickly and easily removing practically the last drop of oil from a barrel by means of compressed air, and placing it in a tank located almost any place about the plant where the barrel can be rolled or where a hose will extend.

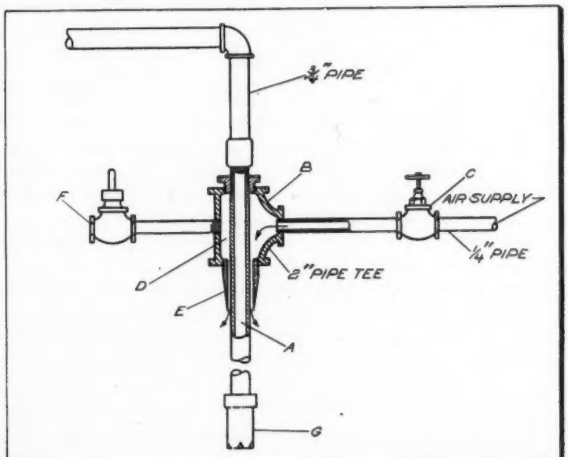


FIG. 1. DEVICE FOR REMOVING OIL FROM BARREL BY MEANS OF COMPRESSED AIR

The long nipple A reaching down into the barrel is threaded back at its upper end to pass through a reducing bushing in the upper end of the 2-in. pipe tee B. This forms an air or pressure chamber D independent of the interior of the pipe A. The lower end of the pipe tee B is fitted with a taper sleeve or nipple E, which is to fit the various sized bungholes of the different barrels with which the device may be used. The air supply from valve C is through a ¼-in. pipe, and passing out of the chamber D around the pipe A exerts its pressure over the top of the oil, forcing it up through the pipe A to the delivery end and into the storage tanks. The side opposite the air supply pipe connection is drilled and tapped out for a ½-in. short nipple, to which is attached the safety valve F. The safety valve is readily made from an old ½-in. globe valve by removing the threads from bonnet and stem and inserting a spring of a moderate degree of resistance to hold the valve to its seat, Fig. 2.

To the lower end of the pipe A is attached the sliding sleeve G to reach to the bottom of the barrel in

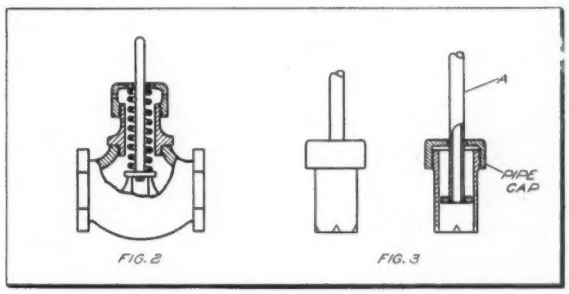


FIG. 2. CROSS SECTION OF SAFETY AIR VALVE
FIG. 3. CONSTRUCTION OF EXTENSION FITTINGS

case its diameter should be of a size to prevent the nipple A from getting near enough to empty the entire contents. The sleeve G is also constructed of pipe fittings in the manner shown by Fig. 3.

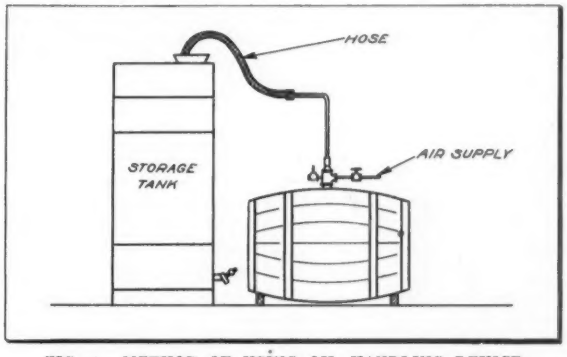


FIG. 4. METHOD OF USING OIL HANDLING DEVICE

The whole arrangement is inexpensively and easily constructed, and will save a great amount of hard and disagreeable work in connection with the handling of engine oils around any establishment where there is access to compressed air. F. W. Bentley, Jr.

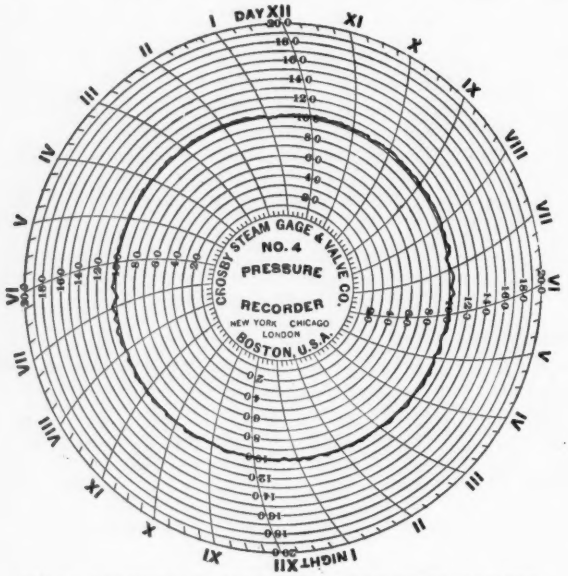
STEEL PULLEYS are now so frequent a sight in power plants, that we frequently forget that it is but a short time that they have been in use.

It was in 1895 that Thomas Corscaden exhibited a model of what has since become widely used as the American steel split pulley. It was received, however, but cautiously for a long time, and it was only several years later that a company was formed in Philadelphia to manufacture these pulleys. The reception given the pulleys was, however, gratifying as soon as they were put on the market. Added to the fact that the material was well suited to stand stresses and blows, these pulleys were correctly designed and built on proper mechanical lines. Experience showed that they had small slippage, and that the grooved air escape permitted a close belt grip. Their lightness was also in their favor, and the split pulley idea, with tight grip on the shaft, avoided the use of keyways and set screws.

The result was, that more than 2,000,000 American split steel pulleys are now in use, and the large plant of the American Pulley Co., continuously turning out more to supply the demands of the trade, is a monument to the foresight and inventive skill of Thomas Corscaden.

STEAM RECORD

ACCOMPANYING steam record shows what careful attention will do in hand firing boilers. This record was taken from 2 fire tube boilers, 16 by 66; 3½-in. tubes, 10 hr. hand firing with shavings from



STEAM PRESSURE RECORD FROM HAND-FIRED BOILERS

wood working machinery blow pipe. Minimum load was 155 hp., maximum 210 hp. for 10 hr., 125 hp. for 14 hr.

This record is from the plant of the Wright Carriage Body Co., Moline, Ill. L. G. Kelso.

USING CALENDAR AS MEMORANDA

RECENTLY Practical Engineer pointed out that the blank space surrounding the figure on a wall calendar was a convenient place to jot down items which we might wish to remember. With the calendar hung on the wall in a convenient place and a pencil handy, we can at any time of the day jot down any item as it occurs, then at the end of the week or month we can copy onto the regular report sheet. I make a weekly report for the office and a monthly record for myself. I submit calendars with figures for the week beginning June 15, which is typical of other weeks.

FIG. 1. CALENDAR MEMORANDA

It will be noticed the starting and especially the stopping time are somewhat irregular as is common with nearly all flour mills.

We have here a Corliss engine for the mill and a motor for the grain elevator; the current for the motor is purchased of the local power company.

My method of marking the items as they occur is easy to read if you know how. I merely want to show that a calendar page is a convenient place for the purpose. It will be seen that all the items do not occur every day. Beginning with Sunday, C. B. means the boiler was cleaned that day. On the 17th on which nearly all the items appear the explanation is: a—started; b—stopped; c—hours run; d—extra stop at 8:30, cause, choke in mill, time shut down, 20 min.; e—pints oil for mill; f—between coal bin and boiler room we use a car holding 1350 lb., f means 4 cars; g—wheelbarrow loads ashes; h—pints compound used; i—pints oil for elevator; j—pints cylinder oil;

ENGINEER'S WEEKLY REPORT

DATE		START	STOP	HR. RUN	HR. MOTOR	KW.	C. OIL	EL. OIL	MILL OIL	COMPOUND	CARS COAL	ASH
JUNE	16	6:55	5:30	10:35	8:30	31	1 PT.		1 PT.	1½ PT.		4
"	*17	6:45	-	10:25	8:10	97	2 "	1½ PT.	2 "	" "	4	3
"	18	6:30	"	11:00	5:20	70	2 "			" "	3	3
"	19	6:40	9:00	14:20	5:35	83	2 "		2 "	" "	4	4
"	20	6:25	"	14:35	3:25	45	3 "			" "	3	4
"	*21	"	2:10	7:45			2 "		1 "	" "	3	4
TOTAL				69:00	25:00	326	18 PT.	1½ PT.	6 PT.	9 PT.	17	22

*STOP AT 8:30 - CAUSE, CHOKE IN MILL - 20 MIN.
" " 2:10 - TO LOAD CAR FLOUR

FIG. 2. WEEKLY REPORT MADE UP FROM CALENDAR MEMORANDA

k—time the motor was run; l—kw.-hr.; m—received 44 tons coal. I also take an inventory the first of each month and from the total engine oil used I deduct the amount used in mill and elevator; the balance is chargeable to the engine room.

I have used the above method for 3 yr. and have found it very convenient. W. A. Watson.

CRUDE OIL REQUIRED

IN answer to the question asked by J. W. N. as to the amount of crude oil required to run a 500-hp. engine, etc., the answer given by Mr. Pierce seems to be rather vague. He states that a 500-hp. engine will not run at a speed of 120 r.p.m. The modern Corliss engine of the heavy duty type is frequently operated at a speed higher than this. I have in mind a 30 by 48-in. long range cutoff Corliss that is rated at 950 hp. that ran perfectly at a speed of 150 r.p.m. on trial, the usual speed being 90 to 110 r.p.m. Another 20 by 36-in. engine runs at a speed of 105 r.p.m., and from other figures that I have on hand I do not agree that a speed of 120 is entirely out of the question for a 500-hp. engine.

The question asks, "How many gallons of crude oil will be required to develop 100 hp. in a 500-hp. engine?" This will depend entirely on the existing conditions such as the kind of oil used, type of burner, type and condition of the boiler, condition of steam line and engine, and many other things which are not given. As the engine is underloaded the steam consumption would very likely be as high as 28 lb. per horsepower-hour, or 2800 lb. per hour for a 100-hp. load. Nothing is said about pumps, and other machinery, therefore these are left out of the question. The quantity of oil required to generate steam in several plants has been found from actual practice to be as follows:

(1) Tests made by the Babcock & Wilcox Co. on Texas crude oil on a 250-hp. B. & W. boiler gave 13.7, 14.4, 15.7, 15.8, 14.2, 15.4 lb. of water from and at 212 deg. per pound of oil, which would mean about 2 lb. of oil per boiler horsepower.

(2) A plant at Galveston, Texas, used 3.7 lb. of oil per engine horsepower, while a plant at San Antonio used 5.5 lb. per engine horsepower per hour.

(3) Tests on the Redondo plant of the Pacific Light and Power Co. shows an equivalent evaporation of 14.2 to 15.7 lb. of water per pound of oil.

(4) A test on a B. & W. boiler at the New Amsterdam Gas Co. plant gives 14.6 lb. of water from and at 212 deg. per pound of oil, and a report from a number of other plants shows that from 12 to 16 lb. of water from and at 212 deg. is about the usual practice.

The weight of crude oil is from 7.5 to 8 lb. per gallon. Assuming 7.5 lb. per gallon, and evaporation of 15 lb. of water per pound of oil, one gallon of oil would evaporate 112.5 lb. of water or 100 hp. would require about 2800÷112.5=24.8 lb. of oil per hour. These figures are of course only approximate, as there are many things that must be taken into consideration in arriving at a close figure. Although a fair comparative cost of the 2 fuels may be had by making certain assumptions in regard to the heat value, specific gravity, gain in efficiency, etc., still it will not enable one to figure the exact saving that would be made by changing from one fuel to the other. The reason is that the saving generally depends on other things than the cost of fuel. The saving in firemen and coal passers, increase in capacity, facilities for storing fuel, advantage of pumping oil over handling coal, elimination of ash handling, coal used to bank fires, elimination of smoke, and other things many of which cannot be figured out in dollars and cents in advance would throw the cost decidedly in favor of oil. The only way to determine the exact saving is to operate the plant with each fuel long enough to get accurate data on all of the items entering into the question.

I judge from the question asked, which gives no details as to size or condition of the plant, that the engineer has figured the comparison on the different items that bear on the matter, and only wishes to know about how much oil will be required in practice to develop one horsepower. The test figures given above are taken from reports made by Prof. D. S. Jacobus, and other authorities, and may be considered accurate.

J. C. Hawkins.

POOR VALVE DESIGN

ACCOMPANYING illustration shows a section through the steam cylinder, chest and slide valve of an engine. This engine had been driving the machinery in a factory for years, and as the load had always been light and the engine seemed to run all right, it had never been indicated.

As more work was going to be added, it was thought well to indicate the engine; card No. 1 was the result. At this time it was not possible to take the chest cover off to see what was wrong with the valves, and it was decided to give the valve some of the lead which it evidently needed, after which card No. 2 was taken, which made a considerable difference in the back pressure, as shown.

Shortly after this the engine was stopped and the cover taken off, and the trouble was located. The draughtsman who had designed the engine must have drawn out the cylinder without having the steam chest in position, and in his efforts to reduce clearance, overlooked the travel of the valve, with the result that the valve touched the bosses surrounding the studs which bolted the steam chest to the cylinder.

The valve over all was about ⅛ in. shorter than the ports and therefore the steam was not cut off, as shown by card No. 1.

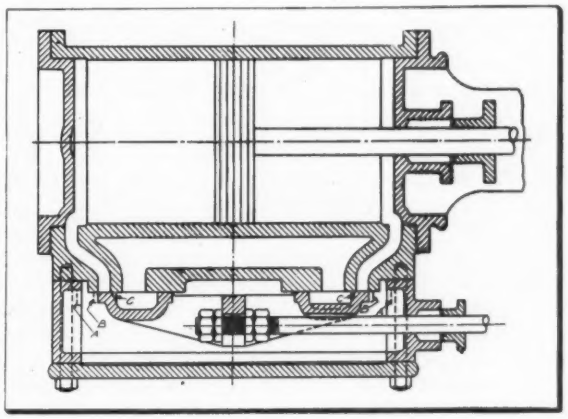


FIG. 1. CHANGES MADE IN THE DESIGN OF A SLIDE VALVE

To overcome the trouble as much as possible we cut out the steam chest, as shown in dotted lines at A, and put strips of metal on the outside edge of valve, as shown at B. We also found that the inside lap was too great, so we cut it out, as shown at C, after which the engine was put together, and when working at its usual load was indicated and card No. 3 was obtained.

Cutoff now took place between ¾ and ⅞ strokes, and while it is not very good, still it is a vast improvement over the condition as shown by card No. 1.

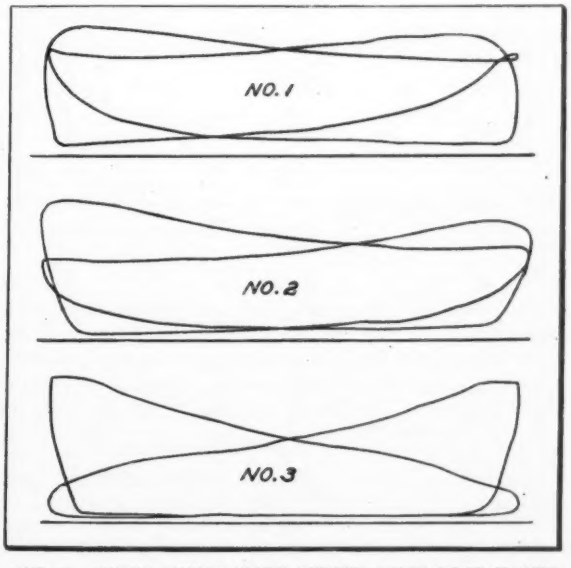


FIG. 2. CARDS TAKEN FROM ENGINE WITH POOR VALVE

Card No. 3 was taken at a speed of about 20 revolutions greater than Nos. 1 and 2, as we increased the horsepower by keeping the m.e.p. the same and increasing the speed, also changed the pulley on the line shaft, the speed of which could not be changed. J. G. G.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Indicator Diagram Showing Late Events

THIS indicator card was taken from a 22-in. Corliss engine, length of stroke 38, r.p.m. 54, boiler pressure 120, indicator spring 50. Please let me know what is wrong with this card. H. I. E.

A. The trouble with this diagram is, that the eccentric has too little angular advance, which makes all the events late. I would suggest as a remedy that you advance the eccentric about 1½ in. on the shaft, as a trial, and take another diagram. This ought to give a diagram very nearly like the dotted lines I have drawn on the card, although it might require more or less than 1½ in. to give the proper distribution, and would have to be determined by trial.

In looking at the original diagram, you will note that the steam valve does not open until after the piston has started on the stroke. This is shown by the sloping admission line. The point of cutoff, and expansion lines are good, although the cutoff is a little later on the right-hand end than on the left-hand end. The point of release does not occur until the end of the stroke is reached, while it should occur a little before the end to give the exhaust steam a chance to escape before the piston starts on the return stroke. As it is, the piston has to travel against a pressure above atmosphere for part of the stroke. This is shown at the point R on the diagram. The exhaust valve remains open until the end of the exhaust stroke is reached, consequently there is no compression to aid in stopping the inertia of the reciprocating parts. This is shown at the point C on the diagram. All of these faults will be corrected by advancing the eccentric.

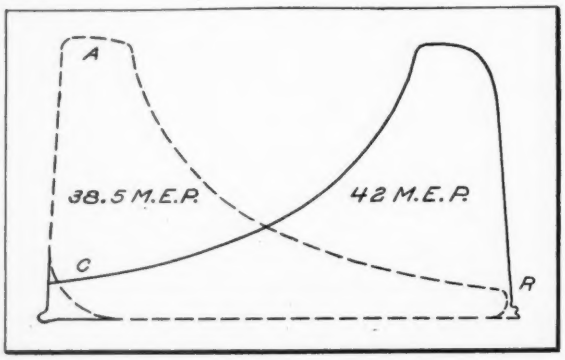


DIAGRAM SHOWING TOO LITTLE ANGULAR ADVANCE OF ECCENTRIC

The unequal cutoff can be corrected after the eccentric has been advanced, by changing the length of the governor rod on the right-hand end of the diagram to give earlier cutoff on that end. After the eccentric has been advanced one end may show a different release or compression than the other end. This can be corrected by adjusting the valve rods as the conditions require, and in this case, can be done while running.

The mean effective pressure is, l.h. end, 38.5 lb.; r.h. end, 42 lb.; average, 40.25 lb. The difference, 3.5 lb., can be equalized by the governor rods. The horsepower is:

$$\frac{40.25 \times 3\,1/6 \times 2 \times (22^2 \times 0.7854) \times 54}{33{,}000} = 158.5 \text{ hp.}$$

Cooling Drinking Water

MY problem is one of supplying cool water for drinking purposes only, in an 8-story building employing about 700 persons. The pressure in city mains is such that a house pump is required in order to have water on top floors. My idea is to have a box of some kind located in the cellar containing coils packed in ice, the water of course passing through these coils. What amount of cooling surface would be needed in the coils? How much water would be required? How much ice would be required to cool this amount of water from 70 deg. to 50 deg.?

This system is to be installed so that none of the water will be used for washing purposes and to reduce other wastes to a minimum. The riser is to be tapped at the different floors. At times when there is little water being used, the contents of the pipe will of course tend to assume the temperature of the surrounding air, and being opposite the conditions of a hot water circulating system, could this be made to circulate without the introduction of some form of propeller? What would be the best material with which to cover this pipe? Also, would not brass or tin lined iron pipe be best for the purpose?

Of course some elaborate system could be installed, or a small ammonia plant would be suitable; but the greatest objection raised by the firm is the first cost.

A. E. C.

A. Calculating the water as used for drinking purposes only, one quart a day per person would be a fair allowance, or 700 quarts total. This would be 180 gal., or about 1500 lb. The lowering of temperature is 20 deg., so that the B.t.u. to be extracted would be 30,000. A ton of ice melting in 24 hr. will take away 284,000 B.t.u., so that the refrigeration required would be 30,000 ÷ 284,000, which would call for about 1/10 of a ton of ice, or 200 lb. If the refrigeration were done by a refrigerating machine, since the cooling would all have to be done in 10 hr., it would require 2.4 times this capacity, or about a quarter of a ton. The average difference in temperature between the ice and the water would be 60 — 32 = 28 deg.; and for an iron pipe coil, the transfer of heat will be about 0.8 of a heat unit per square foot of pipe surface per degree temperature in a minute. Thirty thousand

B.t.u. in 10 hr. would be 3000 an hour, or 50 a minute, and $50 \div (0.8 \times 28)$ would give 2.23 sq. ft. needed in the cooling coils.

A more satisfactory system would be to install a small motor driven refrigerating unit in the attic of the building, and cool the water there. You would then get gravity circulation, as the cold water would drop, and by running in a return pipe, you would get the water, as it became warmer, rising to the cooling tank.

For insulation on your cold water pipes, use either the insulation made for this purpose by the H. W. Johns-Manville Co., or that made by the Armstrong Cork Co., of Pittsburgh. Either would be satisfactory.

The tin-lined iron pipe would of course, be ideal, but an iron pipe with a good heavy galvanizing on it would answer all purposes. I would not advise the use of brass pipe for this purpose. A. L. R.

Questions By Massachusetts Inspectors

THE following questions were asked a short time ago by Massachusetts inspectors:

1. Suppose you had 2 boilers, one 3/8 in. thick, and the other 1/2 in. thick, 100 lb. steam pressure on both; what governs the strength of these 2 boilers?

2. Why cannot Corliss engine valve gear be worked direct from the eccentric, without the rocker arm? J. K.

A. The strength of the boiler is governed by the diameter. The rule for figuring strength of boilers is:

$$D = \frac{2\,S\,t}{p\,f}$$

D is diameter of shell in inches.
S is the breaking stress in the metal per square inch.
t is the thickness of the shell in inches.
p is the pressure per square inch.
f is the factor of safety.

With riveted joints, the formula becomes

$$D = \frac{2\,S\,t\,e}{p\,f}$$

e is the efficiency of the riveted joint.

2. In a Corliss engine, the distance from the eccentric to the wristplate is so long that a direct connection between the two with one rod would require this to be excessively heavy. The rocker arm not only divides the distance, but increases the range of motion for the wristplate. The travel of the wristplate, if it is connected direct to the eccentric without the rocker, would not be the same on each side of a plumb line through its center of support, due to the angle that the rod would make with the horizontal line through the center of the shaft. This would cause difficulty in the design.

Hydraulic Problems

HOW much power can be obtained from a stream of water, which, when measured by a weir dam, was found to have an area of 5 sq. ft. and a head of 25 ft.? A modern turbine is to be used. Give formulas for the calculation.

2. If the water be raised in the mill-pond (which has an area of about 100 acres) 10 ft. above the mouth of the flume, would there be an increase in the power, more than that due to the extra 10 ft. of head?

3. Would the same volume of water produce more power if taken from the bottom of the dam (the height of water in the pond remaining 25 ft.) instead of allowing it to flow over the dam and then down to the wheel? If necessary to know the velocity of the stream in question (1), assume it to be 280 ft. per min.

A. Your first question is far from definite, as you say you use a weir dam, area of which is 5 sq. ft. If you will send a sketch showing the arrangement and what the conditions actually are, I will make definite answer to this question.

2. For the same amount of water you will get power in proportion to the increase in the head of 10 ft., provided the present arrangement allows all of the water to be used and none wasted. Of course, raising the head 10 ft. will increase the storage capacity and this in turn will increase the amount of power that can be obtained provided some of the water is running to waste now under the 25 ft. head.

3. With a reaction turbine it makes no difference whether the water is taken from the bottom of the dam or near the top, provided that the intake is enough below the surface so that the flow is never broken by air being drawn in. I assume that the turbine is of the reaction type rather than the overshot.

C. M. Allen.

Locomotive Power Required; Steam to Melt Ice; Parallel Circuit Problem

A GRADE 1 mile long has a vertical rise of 100 ft. Assuming friction 5 per cent of load, what horsepower will be required to haul a load weighing 100,000 lb. up the grade in 10 min.?

2. How many pounds of steam at 100 lb. absolute pressure would be required to melt 20 lb. of ice at 24 deg. F? In my judgment the temperature of ice cannot fall below 32 deg. F.

3. A group of 3 circuits in multiple is connected across between the live wires of 100-volt circuit. The first circuit has a resistance of 10 ohms, the second a resistance of 25 ohms, and the third a resistance of 50 ohms. (a) What is the joint resistance of the 3 paths in multiple? (b) What is the current in each circuit? (c) What is the rate in watts at which work is being done in each of the circuits? J. P.

A. The formula given by Kent for the resistance of a locomotive is as follows:

$$Rt = (3 + \tfrac{V}{6}) + 0.3788\,G + 0.5682c + 0.01265\,S^2$$

Rt = resistance in pounds per ton,
V = speed in miles per hour.
G = grade in feet per mile,
c = degrees of curvature,
S = rate of increase of speed in miles per hour in a run of one mile.

Substituting your figures, and since you have no curvature and the speed is uniform:

$$Rt = (3 + \tfrac{8}{6}) + 0.3788 \times 100$$

$$Rt = 4 + 37.88 = 41.88$$

$$41.88 \times \frac{100{,}000}{2000} = 2094 \text{ lb.}$$

This formula does not take into account the resistance due to the friction of bearings or air, which you state in your problem is assumed as 5 per cent. Therefore,

$$\text{Friction} = 0.05 \times 100{,}000 = 1000 \text{ lb.}$$

The total resistance, therefore, is 3094 lb. for the load which you state is upon the engine.

With a draw bar pull of 3094 lb., the horsepower necessary to draw the load one mile in 10 min, is,

$$\frac{5280 \times 3094}{10 \times 33{,}000}, \text{ giving } 49.506 \text{ hp. total.}$$

2. The total heat in one pound of steam at 100 lb. absolute pressure per square inch is, according to the tables, 1181.8 heat units.

The specific heat of ice is 0.504, compared with water as 1. To bring the 20 lb. of ice, which is at 24 deg. F., to 32 deg. F., will require,

$$8 \times 20 \times 0.504 = 80.64 \text{ heat units.}$$

To melt the ice, you must add to this the latent heat of fusion, which is, according to Supplee, 142.60, making the total heat units required to melt ice,

$$80.64 + (142.60 \times 20) = 2932.64 \text{ heat units.}$$

Dividing this by the number of heat units in a pound of steam at 100 lb. gage, gives you,

$$\frac{2932.64}{1181.8} = 2.481 \text{ lb. } +.$$

You are wrong in your judgment that the temperature of ice cannot fall below 32 deg. The temperature of ice may reach as low as the surrounding atmosphere.

3a. The joint resistance of a number of circuits in parallel is equal to one divided by the sum of the reciprocal of the several resistances. In your case,

$$R = 1 \div (\tfrac{1}{10} + \tfrac{1}{25} + \tfrac{1}{5} + \tfrac{1}{10}) = 6\tfrac{1}{4} \text{ ohms}$$

3b. The current in the first circuit is found by dividing the voltage by the resistance. Thus,

$$\frac{100}{10} = 10 \text{ amp.}$$

In the second circuit it is,

$$\frac{100}{25} = 4 \text{ amp.}$$

In the third,

$$\frac{100}{50} = 2 \text{ amp.}$$

3c. The power consumed by each circuit is found by multiplying the voltage by the current. Thus, in circuit one,

$$100 \times 10 = 1000 \text{ watts.}$$

Circuit 2, $100 \times 4 = 400$ watts.

Circuit 3, $100 \times 2 = 200$ watts.

Questions on Power Plant Operation

HOW would you determine to a certainty your closed heater was leaking?

2. How would you know the check valves were leaking?

3. Why do piston valves take steam on inside?

4. If you shut down a boiler for 6 or 8 months, whose safety valve had been blowing at 100 lb. pressure and when you started it up again, blew at 50 lb. pressure, with your steam gage O. K., what would be the trouble? W. T. R.

A. To determine positively whether or not the tubes and joints of a closed heater are leaking, shut the engine down so that there is no steam to condense in the heater, then disconnect the drip pipe that carries away the condensation, and start up the feed pump, pumping against boiler pressure. If the pump exhausts into the heater it will be necessary to disconnect it temporarily, then there will be no water from the drip pipe except that which leaks through the tubes and joints.

2. This question I believe has reference to the check valves in the feed line. To determine whether they leak, stop the feed pump and close any convenient valve between the hand regulating valve or automatic regulator, if there be one, and the pump. Next close the valve between the check valve and boiler—the boiler is of course under pressure—then remove the bonnet of the regulator or hand regulating valve or disconnect a union in the pipe near the check if there is one there, and open the valve between the check and boiler. If the check leaks, hot water will flow from the opening made in the pipe.

3. The principal reason that piston valves are constructed to take steam in the center is, that steam is supplied to the middle of the steam chest, and exhausted from the ends, which arrangement secures the advantage that the supply and the exhaust are kept well separated so that heat cannot easily pass from one to the other without first going through the cylinder and doing work, and also the valve rod stuffing box is exposed to the exhaust pressure only, and therefore need not be so tightly packed. This arrangement has the disadvantage, however, that when a vacuum is carried in the exhaust pipe air may leak in around the valve rod without being detected.

4. If the safety valve formerly blew off at 100 lb. pressure, and on starting up after 6 or 8 months shut-down it blew at a pressure of 50 lb., it would certainly appear that the valve had been tampered with, possibly it may have been examined and cleaned and not readjusted, or the adjusting screw may have been turned with malicious intent. In any case if the safety valve and steam gage did not correspond I would test the gage to make sure that it was correct, a safer way would be to use 2 gages. If the safety valve is at fault instead of the gage take it apart and examine, clean and oil the parts. After putting it on again, if found to be in good order, fire up the boiler to the safe pressure and adjust the valve to blow off at the desired point. Under no circumstances should the adjusting screw be turned to make it blow off at a higher pressure until absolutely sure that the safety valve is at fault. This is one of the main causes of boiler explosions. J. C. Hawkins.

AS A SUBSTITUTE for horse and mule teams for transferring loaded freight cars from one station to another, the Pennsylvania Railroad has built an electric tractor,—a giant electric automobile which will do the work of 20 mules. To determine the strength of the tractor, the company arranged a tug of war between it and a steam locomotive.

Two freight cars were put between the tractor and the locomotive; the power of the latter was first turned on and after the 2 cars and the tractor had been pushed a short distance, the electric current was applied very gradually. The power in the locomotive and the tractor was increased until each exerted its full strengeth. The motor developed the stronger power, pushing the 2 cars and the steam locomotive to such an extent that the wheels of the latter slipped on the track.

The tractor is equipped with 2 motors, each having a capacity of 20 hp.; it weighs 28,850 lb., each wheel alone weighing about a ton. The wheels are 60 in. in diameter and are fitted with hard rubber tires similar to those on automobile trucks. The truck straddles the railroad tracks, which are laid flush with the pavement.

As showing the capacity of the tractor, it can start a draft of 6 loaded 50-ton freight cars on the mountain grade of the Pennsylvania railroad.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Time Required to Empty Tank

HOW long would it take to empty a tank 10 ft. high by 8 ft. wide, having 4 pipes whose sizes are 2, 1½, 1¼ and 1 in. respectively? M. I. T.

Increasing Capacity of Chimney

WHY does it require 4 times the height of a stack or chimney to double its capacity but only twice the area, the height remaining the same? Or, in other words, why does the capacity of a stack vary as the square root of the height and directly as the area of the base? J. W. D.

Position of Valve on Steam Outlet

THE new Indiana law concerning boilers, says we must have a valve on the steam outlet not more than 18 in. from the boiler. As the header in most plants is much higher than this, it seems to me the arrangement spoken of will be bad in that it forms a pocket where condensation may collect and start a water hammer when the valve is opened, that might be disastrous in its effect.

I should like the views of other readers on this clause of the law. J. O. B.

Commutator Trouble

I AM having a little trouble with an exciter commutator. This exciter is a 4-pole, 120-volt, 5-kw. machine, running at 1375 r.p.m., exciting a 200-kw., 550-volt Western Electric Co. alternator. The trouble is in the commutator cutting. When I first came here, there were carbon brushes on it. I put graphite-treated brushes on and it helped some, but did not stop it. I have used Gale's commutator compound. There is no sparking and the commutator does not get very hot. If anyone has anything to offer that would help in overcoming this trouble, I should be glad to hear it. D. S. P.

Length of Indicator Cards

IS it not a mistake for indicator cards on a steam engine, Corliss type, with same springs and same cord, to vary in length of card? A man that has been running engines for about 35 yr. claims that cards vary, one card measuring 4 in., and the next 4⅛ in.

This engine has run for only 12 yr., and it had to be bored, both valves and cylinder. The cylinder has St. John's packing on the piston, the piston rod, and also on the valve stems, live steam, also exhaust. The main shaft swings; as it has a 12-ft. flywheel and an outside pedestal bearing, the load varies. Would this lost motion in pedestal boxes and wristpin, also crank bearing, not be the only way this card could vary? He claims that different loads make the indicator produce these different length cards. Do you think an engine running this short time should be so much out? W. I.

Compressor Problem

IN our plant we have a 9⅛ by 15-in. horizontal double-acting Wolf Linde ammonia compressor, direct connected to a 12 by 30-in. Murray Corliss engine.

We had the compressor bored and a new head fitted before starting up. This head is the old one turned down and a band shrunk on and turned up with 2 rings just like a high speed steam head. The head is oval and they lacked 1/64 in. of turning the ends of band down to the head. We also had a new crankpin put in the compressor crank.

When I went to assemble the machine I found that there was only 1/64 in. clearance or 1/32 in. in all. The adjusting screws are threaded 4 to the inch, so it will be seen that it was a neat job to divide the clearance. Now, why does the head strike the crank end head when starting up after being shut down 6 or 8 hr.? I contend that when the rod gets cool it contracts enough to overcome the 1/64-in. clearance.

I should like to hear from some of the readers on this clearance, also what they think of the way that piston was upset. C. C. G.

Cause of Broken Shaft with Rope Drive

WE have one rope drive in our mill with shafts 30 ft. on centers, with 2 8-rope sheaves 40 in. in diameter, 1¼-in. rope, 2 15/16-in. shaft, and operated with tension carriage. This shaft has broken 4 times within the past 18 months.

We have another rope drive 80 ft. on centers, with 2 6-rope sheaves 40 in. in diameter, 1-in. rope, 2 15/16-in. shaft, and operated with tension carriage. Have been operating the latter for about 4 months now, and this shaft broke this evening. The break occured each time in the pulley.

The hangers are 5 ft. on centers for the 80-ft. drive and 3 ft. on centers for the 30-ft. drive. A. M. C.

A. Take out the 2 15/16-in. diameter jack shaft on the 8-rope sheaves drive and replace this with a 4-in. shaft. For the best economy, this drive should not do more than 120 hp.—undoubtedly you are doing very much more.

The 2 15/16-in. shaft on the 6-rope drive should be replaced by a 3¼-in. shaft.

We believe your trouble is caused by the shaft crystallizing, and the only way to overcome this is by placing hangers nearer the pulley or by putting on a larger shaft to overcome the torsional strain.

The conditions when using rope drives or belting are very much in favor of the rope drive as far as the strain on the shaft is concerned, providing the same amount of power is delivered to the driven shaft, and it would not help this in any way to replace the rope drive with belts unless you put in heavier shafting.

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THE ECONOMIC POWER HOUSE

The controversy between the advocates of the "central station" and those of the "isolated plant" is one in which practically every industry is interested, and will have considerable weight in the future development of the resources of the country. Each side puts forward certain advantages and cites examples of gain to the consumer from the adoption of a certain policy. The result: both sides would appear to be in the right. The central station under the same conditions, undoubtedly can produce power at the switchboard more economically than the small plant, but whether it can also supply power more cheaply depends largely upon local and individual circumstances. Common sense must determine the rational and efficient solution of the question in each case and this opens up consideration of a state of affairs that does not seem to be generally recognized. Proportionally to its output, a small plant does cost more to operate than a large one, but there is a certain size of power house which might be referred to as the "critical plant," plants smaller or larger than which cannot be operated with as good relative economy.

A careful study of the total cost of power production in a great number of plants of various sizes and operating under diverse conditions shows that for steam power the "critical plant" has a capacity of about 1000 hp. and that this is true no matter what the service of the plant—i.e., whether operated but comparatively few hours a day or continuously. There is some slight difference in relative efficiencies between plants operating on coal and those using oil as fuel, but the critical plant is of the same capacity in either case.

With coal as the fuel, it costs nearly 3 times (2.95) as much per horsepower-hour to operate a 100-hp. plant as it does in a 1000-hp. plant, and slightly over 3 times (3.04) as much per horsepower-hour to operate a 100-hp. plant as it does a 1000-hp. plant with oil as fuel.

Between these 2 sizes of power plants the economic gain of enlarging the power house is very nearly constant for each additional 100 hp., being about 14 per cent for each 100 hp. increase in capacity of the coal burning plant and about 13 per cent in the case of the oil burning plant.

Power houses of larger capacity than 1000 hp. show greater economy in the cost of power production, of course, but the gain is much more gradual than in the smaller plants, the critical plant representing the point where the gain in economy changes from rapid increase to comparatively slight. That is to say, the gain in economy of power production in plants larger than the critical plant is, in coal burning plants, but about 14.5 per cent for each 1000 additional horsepower capacity and about 13 per cent in the case of oil burning plants. These gains in economy are slightly greater just after passing the capacity of the critical plant and gradually decrease as the capacity of the plants becomes relatively great, but the mean gain is close to the above percentages and is practically constant.

A plant of 1000-hp. capacity is larger than the great majority of individual plants, and plants that are larger than this critical plant are not usually supplied from central stations. Furthermore, the central station usually charges prices varying inversely as the consumption of power by the consumer.

For the greatest economy, therefore, consumers using but a few hundred horsepower would realize considerable benefit by combining, as far as their power requirements are concerned, and operating one power house of about 1000-hp. capacity for their common use, pro-rating the cost of operation. Such combination of interests, however, would have to be between adjacent plants in order to avoid transmission losses or heavy repair burdens, such as prevent the central station successfully competing with an efficiently operated but much smaller isolated plant. Where conditions do not permit of such combination, careful study of actual costs, not guesswork, for an efficiently run plant and prices which can be secured from the central station service will determine which course is the wise one, and this should be followed, without bias or prejudice in favor of either form of power supply.

NEWS NOTES

THE TERRY STEAM TURBINE Co., Hartford, Conn., has appointed Heshall, Simmons & Co., 502 Randolph Building, Memphis, Tenn., as its agents for that city and the territory of Tennessee, Arkansas, and the northern part of Mississippi.

H. W. JOHNS-MANVILLE Co. has recently opened a branch office at Charlotte, N. C. The new office, which is located in the Commercial Bank Building, is in charge of E. U. Heslop, who is assisted in covering the western section of North Carolina by P. J. McCusker and Paul W. Whitlock.

A JOINT ANNUAL MEETING of the Canadian and American Peat Societies will be held at Montreal, Canada, on August 18, 19 and 20, 1913. Opportunity will be given members of the societies and their friends to visit the 2 largest peat fuel plants on the Continent, and see them in full operation. These are located at Farnham and Alfred.

THE AMERICAN BOILER MANUFACTURERS' ASSOCIATION will hold its 25th Annual Convention in Cleveland, O., September 1 to 4, with headquarters at the Hollenden Hotel. There will come up for consideration, a proposed standard specification for boilers and boiler sheet, which makes the meeting of unusual importance. This is also the Silver Anniversary of the Association, and special effort has been made to provide an excellent program of technical work and intertainment. An excursion on the lake is arranged for Wednesday, September 3, the banquet for Thursday evening, September 4. All makers and users of steel plate are invited to attend.

THE GOULDS MANUFACTURING Co., Seneca Falls, N. Y., announces the recent appointment of F. Z. Nedden of London, Eng., as engineer in charge of the centrifugal pump department. Mr. Nedden's technical education was obtained at the Technical University of Berlin at Charlottenburg, where he graduated with high honors. His early practical training was obtained in the shops of the Berliner Maschinenbau A. G. vormals L. Schwartzkopff in Berlin and Wildau, from 1899 to 1906. From 1906 to 1908 Mr. Nedden was assistant professor on gas and rotary engines, and machines at the Technical University, Aix-la-Chapelle.

Later he joined the Machine & Pump Factory of Messrs. Weise & Monski, Halle, Germany, and developed its line of high lift turbine pumps, was transferred to London and from that period until 1913 developed the English and Colonial business.

Mr. Nedden has recently been making an extensive trip through the United States studying the technical and economical conditions of the market for centrifugal and turbine pumps and has now taken up his duties with The Goulds Mfg. Co., at Seneca Falls.

THOMAS R. ARMSTRONG, of Boston, has been appointed a member of the Massachusetts Board of Boiler Rules, to represent the operating engineers of the state, and the engineers as well as the state are to be congratulated on this choice.

Mr. Armstrong is an engineer of large experience, having been a commissioned engineer in the U. S. Revenue Service, an engineer officer in the U. S. Navy, chief engineer of vessels in the Merchant Service, and has held positions in stationary plants, as chief engineer in public institutions of Boston, the Sears Estate, the Mason Machine Works, at Taunton, inspector of engineering for the Japanese government at Cramps shipyards, Philadelphia, superintendent of construction for the C. E. Cotting Estate, Boston, and at present is chief engineer for the Boston Safe Deposit & Trust Co., and also is in charge of the U. S. ships Chicago, Rodgers, and Macdonugh, attached to the U. S. Brigade, holding the rank of Lieutenant-Commander.

Mr. Armstrong was selected as a candidate for the Massachusetts Board, and recommended to the governor by the New England Society of Superintending Engineers, a choice which does credit to the wisdom and high ideals of that society. The society has also recommended to the governor, as Chief Inspector of the Boiler Inspection Department, George Luck. His appointment would be as satisfactory in that position as is the appointment of Mr. Armstrong to the Massachusetts Board of Boiler Rules.

THE ERECTION OF a mammoth power plant in either Clarion or Jefferson county, Pa., which would supply electric power to Franklin and other towns even as far distant as Erie, is in contemplation by capitalists in a position to finance such an undertaking. Their representative has made a thorough investigation of the matter and has reported it to be feasible.

Coal rather than water will be used to generate the electric current, and the object of locating the plant in either Clarion or Jefferson county is to have it near the coal supply. An effort will be made to find consumers in every hamlet and town within a radius of 150 miles. It is aimed to furnish power to manufacturing plants and domestic consumers, and it is said that the rates will be lower than those at present charged by plants that are now established. The concern will be such a boon to many communities that it is expected the project will receive encouragement from them.

If a power plant using coal can be erected close to the supply of fuel, steam is cheaper than water power for generating electricity, experienced men say. In the first place, the initial investment of capital required to erect a steam plant is not ¼ of that required for constructing dams. The uncertainty of water power is another factor that must be taken into consideration. During the dry seasons there may not be sufficient water to furnish the power required, a fact that has been demonstrated at such a favorable location as Niagara Falls. Many large manufactories there deriving their power from this source have installed steam plants to guard against lack of water and accidents.

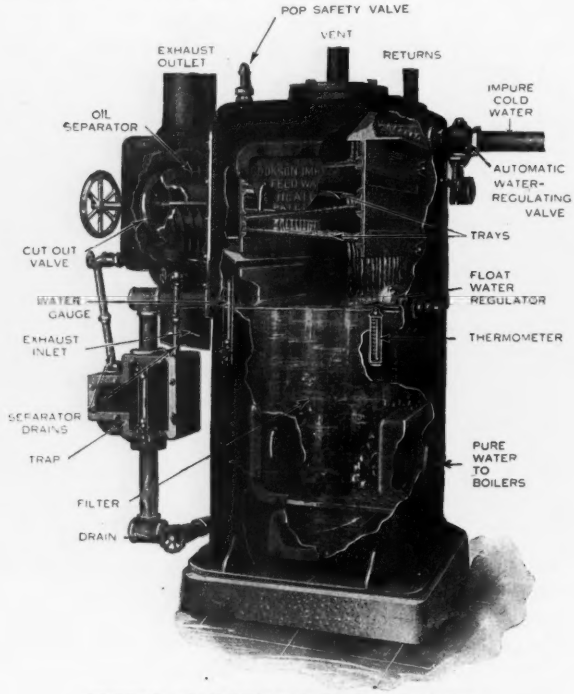
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

COOKSON ONE-PIECE HEATER

A NEW type of cast-iron heater is now being offered by the Bates Machine Co., Joliet, Ill., the body being cast in one piece to give greater strength, durability, handsome appearance and other advantages over the former Cookson cast-iron heaters.

The single casting does away with bolts and calked points at all points save the oil separator, the manhole and handhole covers, and the pipe fittings. It is evident that the more solid construction is practically indestructible and capable of safely withstanding the greatest back pressure that might ever build up within the heater with the safety pop valve set to blow even at 25 lb. per sq. in.



SECTION OF COOKSON ONE-PIECE HEATER

Large steam space, tray surface and filtering space, are afforded and the 4 large manholes and handholes make cleaning easy. Cleaning doors are conveniently located in front and back and as the heater may be made right or left handed by turning half way around, it will fit into a plant without complications in the piping.

The oil separator is made in either of 2 types.

First, extra large and with cutout valve so that all the exhaust is purified, so that the surplus over feed-water heating requirements is in the best possible condition for re-use in heating or processing systems, while the cutout valve permits shutting off the body of the heater for cleaning, without interfering with the action of the oil separator.

Second, standard oil separator which permits piping of the heater on the thoroughfare or induction principle and assures oil elimination from as much exhaust as is required for feed-water heating.

A steam trap and return openings are provided so that the heater may receive the returns from a steam heating system or not as desired.

TO TIGHTEN LOOSE BELTS

THE problem of taking up the slack in belts which have stretched, or of taking out the stretch of new belts in lacing them, especially in large sizes, is always difficult. Belt clamps which work by means of screw rods at each side, are effective but slow, and require careful manipulation.

A new form of clamp for this purpose is now available, manufactured by the Higgins Machinery Co., of Seattle, Wash., and is made as shown in the illustration. The method of using is obvious, and the ease with which the ends of a belt may be brought square together is also evident.

REDDING BELT CLAMP

The new clamp, which is called the Redding Three Minute Belt Clamp, can be applied, even in the largest sizes, by one man and the gear and pinion action enables any tension required to be put on the belt, with the certainty that it will be stretched evenly throughout its width. The clamp is made in sizes to take belts from 8 in. maximum to 24 in., and is designed to stand the maximum load allowable on a belt without danger of breaking any part of the clamp. Further details can be obtained from the manufacturers.

HEINE TWO-DRUM BOILERS

IN larger sizes Heine Boilers are built with 2 drums and suitable water legs with the tube surface usually arranged in 2 passes.

Figure 1 is from a photograph taken at the Ayer Mills, Mass., during the erection of a number of 600-hp. Heine boilers, built for 200 lb. working pressure, and shows clearly the construction of the water legs. The boilers in the foreground are upside down, and the man shown is riveting the water leg to one of the drums. The handhole openings in the waterleg show the arrangement of the tubes, first the lowest row (the upper row in the photograph) on which are placed tiles forming the roof of the combustion chamber, next a bank of 8 rows of tubes forming the first pass, and then a bank of 7 tubes forming the second pass.

Figure 2 is a longitudinal section of a 635-hp. boiler as installed at the Service Plant of the Grand Central Terminal, New York City. It shows the horizontal baffling on the lowest row of tubes, extending over the furnace and back over the bridge wall, thus forming the roof of the combustion chamber. The middle baffle is located in this boiler on the ninth row of tubes, and consists of a special cast-iron baffle, extending from the rear water leg toward the front water leg with a sufficient opening for the passage of the gases. On the top row of tubes are placed T tiles, similar to those on the bottom, extending from the front water leg to within a few feet of the rear water leg. The travel of the gases is obvious. The effective path of travel is long, and the boiler surface is compactly arranged, so that there is efficient absorption of the heat in the gases, even with comparatively high furnace temperatures resulting from the design of combustion chamber.

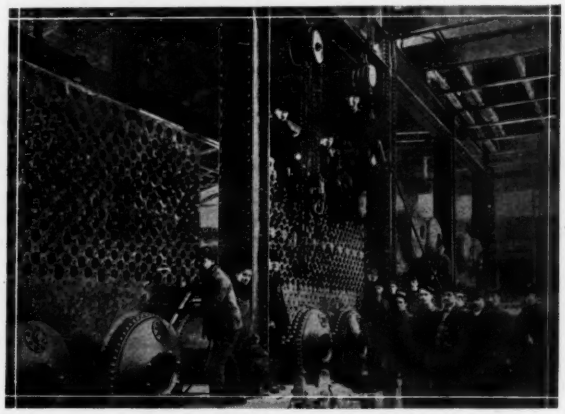


FIG. 1. TWO PASS HEINE BOILERS UNDER CONSTRUCTION AT LAWRENCE, MASS.

Another interesting point shown in this drawing is the superheater design. Two superheater units are used for each boiler, located above the water line in a fire-brick chamber formed on each side of the setting. A flue connects each chamber with the furnace, and a small per cent of the furnace gases flows up these flues and supplies heat for the superheater tubes. The hot gases make 2 passes over the superheater tubes and then flow out of the superheater chamber at the end nearest the front header, and before reaching the uptake they pass under the boiler drum. A damper in the superheater outlet gives complete control of the amount of gases flowing over the tubes, thereby permitting of temperature regulation and also of entirely cutting off the supply of hot gases when saturated steam is desired, or when there is no boiler load. No provision is made for flooding the superheater as that operation is unnecessary, which avoids deposits of scale-forming impurities within the superheater tubes.

The performance of one of these 635-hp. units at the Service Station of the Grand Central Terminal with anthracite Buckwheat No. 2 of heat value 10,880 B.t.u. per pound and natural draft, showed efficiencies considerably above 70 per cent and 6.3 lb. water evaporated from 41 deg. F. to steam at 176 lb. gage and 122 deg. superheat per pound of coal.

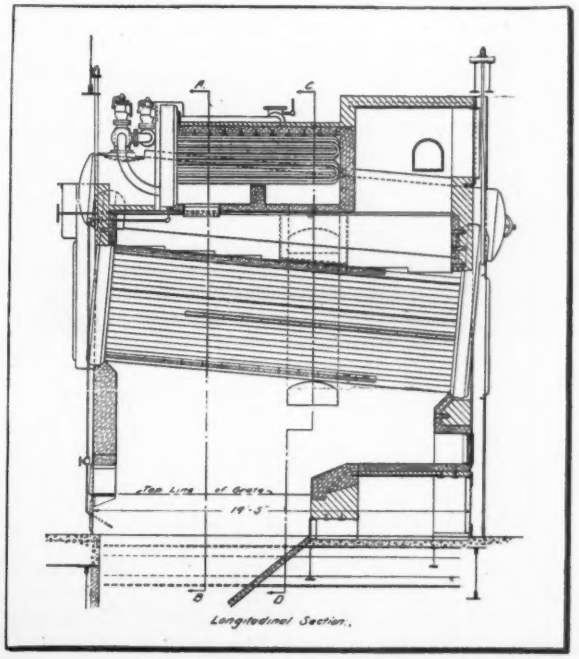


FIG. 2. LONGITUDINAL SECTION OF 635-HP. BOILER AT GRAND CENTRAL TERMINAL PLANT

INDESTRUCTO FIRE TOOLS

THESE are of standard pattern, but are of a new composition metal which has been worked out especially to withstand the hard use necessary for such tools. The patterns have been kept standard with those which practice has shown to be the most convenient and effective, but the material is a high heat resisting alloy, which does not burn out and does not change shape.

Another advantage is that the opening for the handle bar is tapered from front to back. The bar is, therefore, inserted hot, then hammered up, giving a cone larger at the back than at the front, so that the tool does not tend to pull off the handle.

Three tools are made, the hoe, the rake, and the tee bar, or slice bar, by the Indestructo Fire Tool Co., 25 Sellers Ave., Philadelphia, Pa.

IN THE LONG run men hit only what they aim at. Therefore, though they should fail immediately; they had better aim at something high.

—Thoreau.

MICARTA

New Insulating Material

A REMARKABLE new material to take the place of hard fiber, glass, porcelain, hard rubber, built-up mica, pressboard, rawhide, molded compounds, etc., has been developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. It is known as Micarta.

It is used for commutator bushings and brush-holder insulation, as noiseless gear banks, as conduit for automobile wiring, as spools for spark coil and magnet windings, for refillable fuse tubes, for wireless coil separator, for arc shields in circuit-breakers, for water-meter disks, etc.

Micarta is a tan-brown, hard homogeneous material having a mechanical strength about 50 per cent greater than hard fiber. It can readily be sawed,

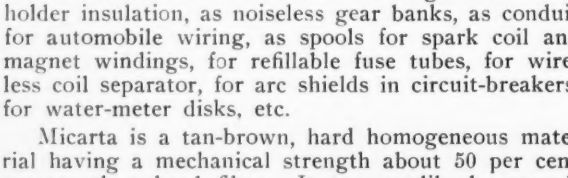


FIG. 1. NATURAL FRACTURE OF BAKELITE MICARTA

milled, turned, tapped, threaded, etc., if a sharp pointed tool is used and the work done on a lathe. It can be punched only in thin sheets and cannot be molded. Micarta is not brittle and will not warp, expand, or shrink with age or exposure to the weather but takes a high polish, presenting a finished appearance.

Two grades of the material are made. The grade known as Bakelite Micarta will stand a temperature of 300 deg. F. continuously, or 500 deg. F. for a short time. It is infusible and will remain unaffected by heat until a temperature sufficient to carbonate it is reached. Heat will not warp Bakelite Micarta, and it will stand an electric arc better than hard fiber,

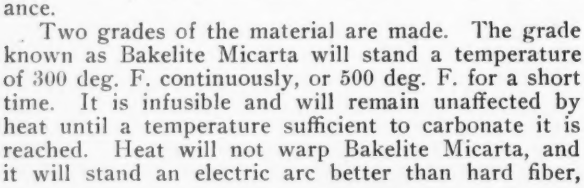


FIG. 2. TUBE PARTS MADE OF MICARTA

hard rubber, built-up mica, or any molded insulation containing fibrous or resinous materials. Its coefficient of expansion is low, being approximately 0.000,02 per deg. C.

Bakelite Micarta is insoluble in practically all of the ordinary solvents such as alcohol, benzine, turpentine, and weak solutions of acids and alkalis, hot water and oils. It is indifferent to ozone—an advantage for electrical purposes. It is nonhydroscopic and impervious to moisture.

The other grade designated as No. 53 Micarta has the same mechanical and electrical properties as the Bakelite Micarta, but differs in its chemical and thermal properties. The plain Micarta behaves toward chemicals and heat very much as an ordinary resin. This grade is not used in plate form.

As proof of the uniformity of structure of Bakelite Micarta, the accompanying illustration of a fracture is shown. This is not a saw cut, but a natural break. The tube was held tight on a metal mandrel and a compressive force was applied at one end of the tube. When the force became sufficiently great the tube split as shown. The uniformity of the wavy fracture shows how homogeneous the material is. Such a break is known as a "harmonic fracture." The strains in a homogeneous material under stress follow a sine wave law. If one part of the material is weaker than the rest, the strain at this point becomes greater and the harmonic wave is distorted. It will be seen, however, from the illustration, made from an actual photograph, that the strain followed the true harmonic wave almost as closely as the eye can detect, indicating that every part of the material was exactly as strong as every other part.

NOTE OF ACKNOWLEDGEMENT

IN the July 15 issue of Practical Engineer, an article by Geo. W. Christians, on Drying out the Dayton Lighting Plants, was published, and by an oversight, acknowledgment was not made to The Electric Journal, of Pittsburgh, from which the article was taken.

Mr. Christians is foreman of the Testing Department of the New York Edison Co., and was in Dayton at the time of the flood, assisting in putting the plants into shape, and prepared the article especially for The Electric Journal.

NEW POWER PLANTS

THE BRITT (IOWA) ELECTRIC LIGHT AND PLANT CO. is building a large brick addition to its present plant. When completed Britt is likely to have an all day and all night service.

WORK HAS BEGUN on a new $50,000 municipal electric light plant at Cedar Falls, Iowa. The city has awarded contracts for electrical and mechanical equipment, and will construct its own building and pole lines under the supervision of the city engineer.

GOSHEN (IND.) LIGHTNING ROD Company will build an addition to its plant this fall. This is one of the many flourishing and growing industries in Goshen. The development of the business has been steady and rapid. Nearly all the parts are now made at the Goshen plant.

DONOVAN & DONOVAN has been awarded a $20,000 contract for a new power plant at Ladycliffe Academy in Highland Falls, N. Y. The contract calls for a complete plant, consisting of new boilers, electric lighting outfit complete, and a brick chimney 120 ft. high. The boiler will be equipped with Jones' automatic stokers.

AT A COST OF $100,000 the Republic Iron and Steel Co., of Alabama, will erect an electric power plant at East Thomas, according to announcement made recently. It is stated that the plant will be capable of furnishing sufficient power to supply the furnaces at Thomas. In addition it is planned by the company to generate power at the Thomas plant to operate Sayreton mines and 3 other openings with electric power. It is stated that the company contemplates some new openings that have not been announced when the power plant is in operation. Transmission lines of high voltage will be erected between Thomas and Sayerton.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time. A handy, serviceable, loose-leaf cover in which to preserve them.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

HORSEPOWER OF GAS ENGINES

Using Natural Gas 1000 B. t. u. per cu. ft.

S = piston speed, ft. per min.

N = number of cylinders.

4 Cycle—hp = C × S × N., based on 77 lb. m. e. p. and 85% mechanical efficiency.

2 Cycle—hp = C′ × S × N., based on 67 lb. m. e. p. and 71% mechanical efficiency.

Diam. of Cyld. inches	Constant C	Constant C′	Diam. of Cylind. inches	Constant C	Constant C′	Diam. of Cylind. inches	Constant C	Constant C
2½	.00241	.0035	9¾	.0368	.0535	17	.1116	.162
2¾	.00294	.00427	10	.0386	.056	17½	.1152	.167
3	.00347	.0050	10¼	.0407	.059	17¾	.1185	.172
3¼	.0040	.0059	10½	.0428	.062	17¾	.122	.177
3½	.00475	.0069	10¾	.0448	.0655	18	.1254	.182
3¾	.0054	.0078	11	.047	.0686	18½	.1289	.187
4	.00617	.0090	11¼	.0492	.0713	18¾	.1325	.192
4¼	.0069	.0101	11½	.0515	.0744	18¾	.1361	.198
4½	.00789	.0114	11¾	.0535	.0777	19	.1397	.203
4¾	.00873	.0127	12	.056	.081	19½	.1434	.208
5	.00965	.014	12¼	.058	.0844	19½	.1472	.214
5¼	.0107	.0155	12½	.0605	.0879	19¾	.1510	.219
5½	.0117	.0171	12¾	.063	.0914	20	.1544	.224
5¾	.0128	.0186	13	.0655	.0951	20½	.1587	.230
6	.014	.0202	13¼	.068	.0988	20½	.1628	.236
6¼	.0151	.0219	13½	.071	.103	20¾	.1666	.242
6½	.0163	.0238	13¾	.0732	.1064	21	.1712	.248
6¾	.0182	.0257	14	.076	.11	21¼	.175	.254
7	.019	.0276	14¼	.0786	.114	21¼	.1792	.260
7¼	.0204	.0295	14½	.0815	.118	21¾	.183	.266
7½	.0218	.0315	14¾	.0845	.122	22	.1874	.273
7¾	.0232	.0338	15	.0872	.126	22¼	.192	.279
8	.0248	.036	15¼	.09	.131	22¼	.196	.285
8¼	.0263	.0383	15½	.093	.135	22¾	.200	.291
8½	.0279	.0406	15¾	.096	.139	23	.204	.297
8¾	.0296	.0431	16	.099	.144	23½	.209	.304
9	.0314	.0456	16¼	.1022	.148	23½	.214	.311
9¼	.0331	.0481	16½	.1054	.153	23¾	.218	.317
9½	.0349	.0508	16¾	.1086	.158	24	.223	.324

PRACTICAL ENGINEER

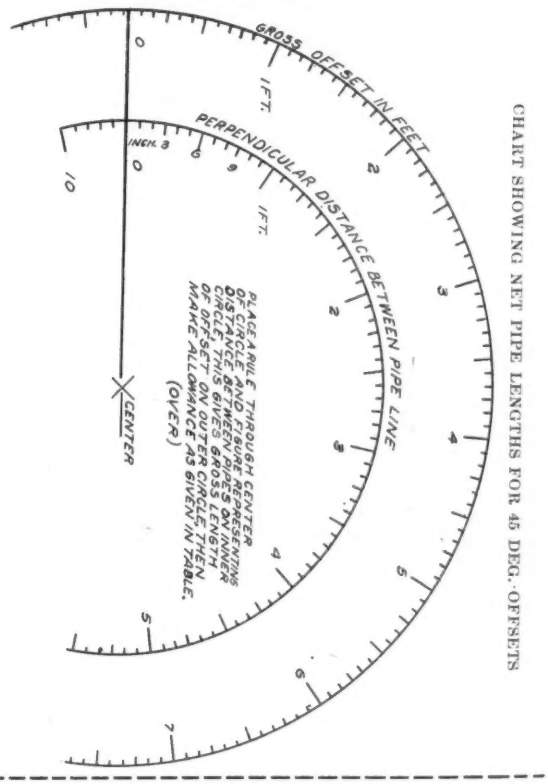

GROSS OFFSET IN FEET
PERPENDICULAR DISTANCE BETWEEN PIPE LINE
INCH. 3
FT.
PLACE A RULE THROUGH CENTER OF CIRCLE AND FIGURE REPRESENTING DISTANCE BETWEEN PIPES OR RUNS. CIRCLE THUS GIVES GROSS LENGTH OF OFFSET ON OUTER CIRCLE THEN MAKE ALLOWANCE AS GIVEN IN TABLE. (OVER)
CENTER

CHART SHOWING NET PIPE LENGTHS FOR 45 DEG. OFFSETS

PRACTICAL ENGINEER

PRESSURE AND HORSEPOWER REQUIRED TO COMPENSATE FOR FRICTION OF AIR PASSING THROUGH PIPES 100 FT. LONG.

B. F. STURTEVANT CO.

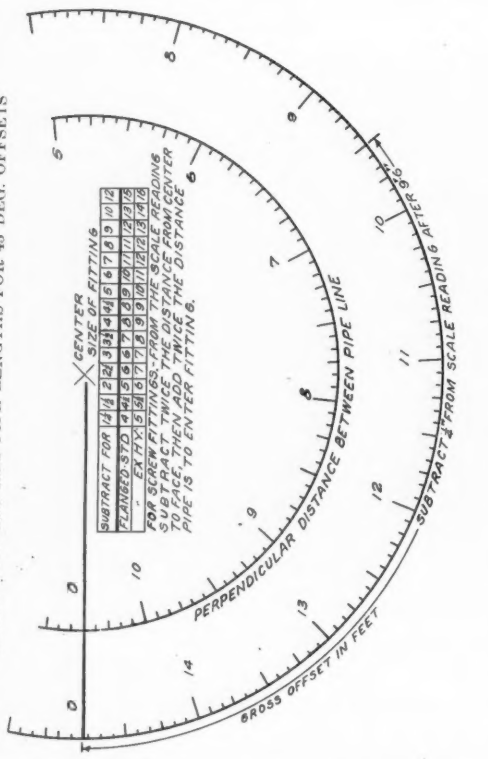
Velocity of Air in Feet per Minute	DIAMETER OF PIPE											
	1 inch		2 inch		4 inch		6 inch		8 inch		10 inch	
	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction
100	0.011	0.0000	0.006	0.0000	0.003	0.0000	0.002	0.0000	0.001	0.0000	0.001	0.0000
200	0.044	0.0000	0.022	0.0000	0.011	0.0001	0.007	0.0001	0.006	0.0001	0.004	0.0001
300	0.100	0.0000	0.050	0.0001	0.025	0.0002	0.017	0.0003	0.012	0.0004	0.010	0.0004
400	0.178	0.0001	0.088	0.0002	0.044	0.0004	0.030	0.0006	0.022	0.0008	0.018	0.0011
500	0.278	0.0002	0.139	0.0004	0.069	0.0008	0.046	0.0012	0.035	0.0017	0.028	0.0021
600	0.400	0.0004	0.200	0.0007	0.100	0.0014	0.067	0.0021	0.050	0.0029	0.040	0.0036
700	0.544	0.0006	0.272	0.0011	0.138	0.0023	0.091	0.0034	0.068	0.0045	0.054	0.0057
800	0.711	0.0008	0.356	0.0017	0.178	0.0034	0.119	0.0051	0.089	0.0067	0.071	0.0085
900	0.900	0.0012	0.450	0.0024	0.225	0.0048	0.150	0.0072	0.112	0.0096	0.090	0.0120
1,000	1.111	0.0017	0.556	0.0033	0.278	0.0066	0.185	0.0099	0.139	0.0132	0.111	0.0165
1,100	1.344	0.0022	0.672	0.0044	0.336	0.0088	0.224	0.0132	0.168	0.0176	0.134	0.0220
1,200	1.6000	0.0029	0.800	0.0057	0.400	0.0114	0.267	0.0171	0.200	0.0230	0.160	0.0286
1,300	1.8780	0.0036	0.939	0.0073	0.469	0.0145	0.313	0.0218	0.235	0.0290	0.188	0.0363
1,400	2.178	0.0045	1 089	0.0090	0.544	0.0181	0.363	0.0272	0.282	0.0363	0.218	0.0453
1,500	2.500	0.0056	1.250	0.0112	0.625	0.0223	0.417	0.0335	0.312	0.0446	0.250	0.0558
1,600	2.844	0.0068	1.422	0.0135	0.711	0.0271	0.474	0.0406	0.356	0.0541	0.284	0.0677
1,700	3.211	0.0081	1.605	0.0162	0.803	0.0325	0.535	0.0487	0.401	0.0649	0.321	0.0812
1,800	3.600	0.0096	1.800	0.0192	0.900	0.0385	0.600	0.0578	0.450	0.0771	0.360	0.0964
1,900	4.011	0.0113	2.006	0.0227	1.003	0.0453	0.669	0.0680	0.501	0.0907	0.401	0.1133
2,000	4.444	0.0132	2.222	0.0264	1.111	0.0529	0.741	0.0793	0.556	0.1058	0 444	0.1322
2,200	5.378	0.0176	2.689	0.0352	1.344	0.0704	0.896	0.1161	0.672	0.1408	0.538	0.1760
2,400	6.400	0.0228	3.200	0.0457	1.600	0.0914	1.067	0.1371	0.800	0.1728	0.640	0.2284
2,600	7 511	0.0290	3.756	0.0581	1.877	0.1162	1.252	0.1743	0.939	0.2324	0.751	0.2904
2,800	8.711	0.0363	4.356	0.0726	2.178	0.1451	1.452	0.2177	1.089	0.2902	0.871	0.3628
3,000	10.0000	0.0446	5.000	0.0892	2.500	0.1785	1.667	0.2677	1.250	0.3569	1.000	0.4462
3,200	11.378	0.0541	5.669	0.1083	2.844	0.2166	1.896	0.3249	1.422	0.4332	1.138	0.5415
3,400	12.844	0.0649	6.422	0.1299	3.211	0.2598	2.141	0.3897	1.606	0.5237	1.284	0.6495
3,600	14.4000	0.0770	7.200	0.1542	3.600	0.3084	2.4000	0.4626	1.800	0.6168	1.440	0.7710
3,800	16.044	0.0906	8.022	0.1814	4.011	0.3927	2.674	0.5441	2.006	0.7254	1.604	0.9068
4,000	17.7780	0.1058	8.889	0.2115	4.444	0.4230	2.963	0.6346	2.222	0.8461	1.778	1.0576
4,200			9.800	0.2448	4.900	0.4897	3.267	0.7346	2.450	0.9794	1.960	1.2243
4,400			10.705	0.2815	5.353	0.5631	3.569	0.8446	2.676	1.1261	2.141	1.4077
4,800			12.8000	0.3655	6.400	0.7310	4.267	1.0963	3.200	1.4620	2.560	1.8275
5,200			15.022	0.4747	17.511	0.9294	5.007	1.3941	3.756	1.8588	3.0042	3.2334
5,600			17.422	0.5804	18.711	1.1608	5.807	1.7412	4.3562	2.3216	3.4842	4.9021
6,000			20.0000	0.7139	10.900	1.4278	6.667	2.1416	5.000	2.8554	4 0003	5.5694

PRACTICAL ENGINEER

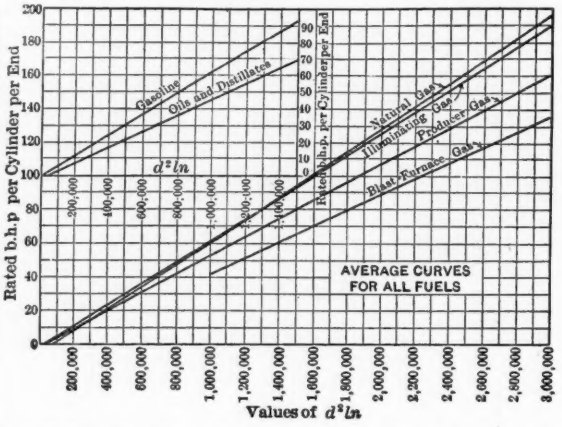
PRESSURE AND HORSEPOWER REQUIRED TO COMPENSATE FOR FRICTION OF AIR PASSING THROUGH PIPES 100 FT. LONG

Velocity of Air in Feet per Minute	DIAMETER OF PIPE											
	28 inch		32 inch		36 inch		40 inch		48 inch		60 inch	
	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss in Press. in oz. per sq. in.	H. P. lost in Friction	Loss in Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P lost in Friction	Loss of H. P in oz. per sq. in.	H. P. lost in Friction
100	0.000	0.0000	0.000	0.0001	0.000	0 0001	0.000	0.0001	0.000	0.0001	0.000	0.0001
200	0.0020	0004	0 001	0.0004	0.001	0 0005	0.001	0 0005	0 001	0 0006	0.001	0 0008
300	0.004	0012	0.003	0.0014	0.003	0 0016	0.002	0 0018	0 002	0 0021	0 002	0 0027
400	0 0060	0030	0 006	0.0034	0.005	0 0038	0.004	0 0042	0 004	0 0051	0 003	0 0063
500	0 0100	0058	0.009	0.0066	0.008	0 0074	0.007	0 0083	0 006	0 0099	0 005	0 0124
600	0.014	0.0100	0.012	0.0114	0.011	0.0128	0.010	0.0143	0.008	0.0171	0.007	0 0214
700	0 0190	0159	0.017	0.0181	0 015	0.0204	0.014	0 0227	0 011	0 0272	0 009	0.0340
800	0 0250	0237	0 022	0.0271	0.020	0.0305	0.018	0 0339	0 015	0 0406	0.012	0 0508
900	0 0320	0337	0 028	0.0385	0 025	0.0434	0.022	0 0482	0 019	0 0578	0 016	0 0723
1,000	0 0400	0463	0 035	0.0569	0 031	0.0595	0 028	0 0661	0 023	0 0793	0 019	0 0991
1,100	0.048	0.0616	0.042	0.0704	0.035	0.0792	0.034	0.0880	0.028	0.1056	0.022	0.1320
1,200	0.0570	0800	0 050	0.0914	0.044	0.1024	0.040	0.1142	0 033	0 1371	0 027	0.1713
1,300	0 067	0.1017	0 058	0.1162	0 052	0.1307	0 047	0.1452	0 039	0 1746	0.031	0 2178
1,400	0 0780	12700	0 068	0.1451	0.060	0.1632	0 054	0 1814	0 045	0.2177	0 036	0 2721
1,500	0.0890	15620	0 078	0.1785	0.069	0 2008	0 062	0.2231	0 052	2.2676	0 042	0 3346
1,600	0.102	0.1895	0.089	0.2166	0.079	0.2437	0.071	0 2707	0.059	0.3249	0.047	0.4061
1,700	0 1150	22730	103	0.2598	0.089	0.2923	0 080	0 3247	0 067	0 3897	0.054	0 4871
1,800	0 1290	27020	0.112	0.3084	100	0.3469	0 090	0 3855	0 075	0 4626	0.060	0.5782
1,900	0 1430	31740	125	0.3627	0.111	0.40800	103	0 4534	0 084	0 5440	0.067	0.6800
2,000	0 1590	37020	139	0.4230	0.123	0.4759	111	0 5288	093	0.6346	0 074	0 7932
2,200	0.192	0.4927	0.168	0.5631	0.149	0.6334	0.134	0.7038	0.112	0.8446	0.090	1.1607
2,400	0 2390	63960	0.200	0.69100	0.178	0 8224	0 160	0.9138	0 133	1 0965	0 107	1.3706
2,600	0.2680	81320	0.234	0.92940	0.209	1 0456	0.188	1 1618	0 156	1 3941	0 125	1.7427
2,800	0 311	01570	0.272	1.16080	0.242	1 30590	0.218	1 4510	0.181	1 7412	0 145	2.1765
3,000	0 357	1.2490	0.312	1 42800	0 278	1 60020	0.250	1 7847	0.208	2 14160	167	2.6771
3,200	0.406	1.5162	0.356	1.7328	0.316	1.9494	0.284	2.1660	0.237	2.5992	0.190	3.2489
3,400	0.4591	81860	0.413	2.09500	0.357	2.33820	321	2.59800	268	3 1176	0 214	3.8970
3,600	0.5142	16200	0.450	2.46710	0.400	2.81560	360	3.08400	0.300	3 70070	240	4.6259
3,800	0 5732	0.53890	0.501	2.90160	0.446	3 26830	0.401	3 62700	334	4 34840	267	5.4406
4,000	0 635	2 96130	0.556	3 38430	0.494	3 80740	444	4 23040	0 370	5 07650	296	6 3456
4,200	0.700	3.4281	0.612	3.9178	0 544	4.0475	0.490	4 8972	0.408	5 8767	0.327	7.3458
4,400	0 768	3.9415	0 672	4.5045	0.595	5 06760	0.535	5 63070	0 446	6.7568	0 357	8.4460
4,800	0.914	5.1171	0.800	5.84810	0.711	6.5791	0.640	7.3101	0 533	8 7722	0.427	10.9642
5,200	1 073	6.5059	0.935	7.43540	0.835	8.36480	751	9 2942	0.626	11 1530	0.501	13 9413
5,600	1 244	8.1258	1.089	9.28660	0.968	10 4474	0.871	10 6082	0.726	13 9300	0 581	17.4123
6,000	1 429	9 9918	1 250	11 4221	1.111	12 8498	1.000	14.2776	0.833	17 1331	0.667	21 4164

CHART SHOWING NET PIPE LENGTHS FOR 45 DEG. OFFSETS


CENTER SIZE OF FITTING
SUBTRACT FOR
FLANGED STD
EX HVY
FOR SCREW FITTINGS.-FROM THE SCALE READING SUBTRACT TWICE THE DISTANCE FROM CENTER TO EDGE THEN ADD TWICE THE DISTANCE PIPE IS TO ENTER FITTING.
PERPENDICULAR DISTANCE BETWEEN PIPE LINE
GROSS OFFSET IN FEET
SUBTRACT FROM SCALE READING AFTER

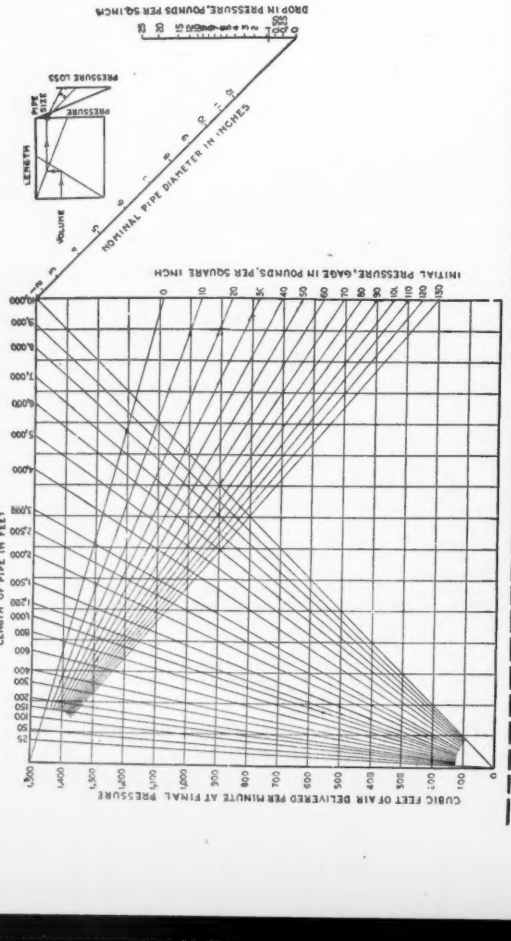
RATED BRAKE HORSEPOWER OF INTERNAL COMBUSTION ENGINES



d = cylinder diameter in inches; l = length of stroke in inches; n = r.p.m.

(Above curves are from Gas Power by C. F. Hirshfield and T. C. Ulbracht)

GRAPHIC SOLUTION OF D'ARCY'S FORMULA FOR TRANSMISSION OF COMPRESSED AIR IN PIPES —COMPRESSED AIR MAGAZINE


DROP IN PRESSURE, POUNDS PER SQ. INCH
PRESSURE LOSS
PIPE SIZE
PRESSURE
LENGTH
VOLUME
NOMINAL PIPE DIAMETER IN INCHES
INITIAL PRESSURE, GAGE IN POUNDS PER SQUARE INCH
LENGTH OF PIPE IN FEET
CUBIC FEET OF AIR DELIVERED PER MINUTE AT FINAL PRESSURE

PRESSURE AND HORSEPOWER REQUIRED TO COMPENSATE FOR FRICTION OF AIR PASSING THROUGH PIPES 100 FT. LONG

Velocity of Air in Feet per Minute	DIAMETER OF PIPE											
	12 inch		14 inch		16 inch		18 inch		20 inch		24 inch	
	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss in Press. in oz. per sq. in.	H. P. lost in Friction	Loss in Press. in oz. per sq. in.	H. P. lost in Friction	Loss of Press. in oz. per sq. in.	H. P. lost in Friction	Loss of H. P. in oz. per sq. in.	H. P. lost in Friction
100	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.001	0.0000	0.000	0.0000
200	0.004	0.0002	0.003	0.0002	0.003	0.0002	0.002	0.0002	0.002	0.0003	0.002	0.0003
300	0.008	0.0005	0.007	0.0006	0.006	0.0007	0.006	0.0008	0.005	0.0009	0.004	0.0011
400	0.015	0.0013	0.013	0.0015	0.011	0.0017	0.010	0.0019	0.009	0.0021	0.007	0.0025
500	0.023	0.0025	0.020	0.0029	0.017	0.0033	0.016	0.0037	0.014	0.0041	0.012	0.0050
600	0.033	0.0043	0.029	0.0050	0.025	0.0057	0.022	0.0064	0.020	0.0071	0.017	0.0086
700	0.045	0.0068	0.039	0.0079	0.034	0.0091	0.030	0.0102	0.027	0.0113	0.023	0.0136
800	0.059	0.0102	0.051	0.0118	0.044	0.0135	0.040	0.0152	0.036	0.0169	0.029	0.0203
900	0.075	0.0145	0.064	0.0169	0.056	0.0193	0.050	0.0217	0.045	0.0241	0.037	0.0289
1,000	0.092	0.0198	0.079	0.0231	0.069	0.0264	0.062	0.0297	0.056	0.0330	0.046	0.0397
1,100	0.112	0.0264	0.096	0.0308	0.084	0.0352	0.075	0.0396	0.067	0.0440	0.056	0.0528
1,200	0.133	0.0343	0.114	0.0400	0.100	0.0457	0.089	0.0512	0.080	0.0571	0.067	0.0685
1,300	0.156	0.0437	0.134	0.0508	0.117	0.0581	0.104	0.0654	0.094	0.0726	0.078	0.0873
1,400	0.181	0.0544	0.156	0.0635	0.136	0.0726	0.121	0.0816	0.109	0.0907	0.091	0.1088
1,500	0.208	0.0669	0.179	0.0781	0.156	0.0892	0.139	0.1004	0.125	0.1115	0.104	0.1339
1,600	0.237	0.0812	0.203	0.0948	0.178	0.1083	0.158	0.1218	0.142	0.1354	0.119	0.1624
1,700	0.268	0.0974	0.229	0.1137	0.207	0.1299	0.178	0.1461	0.161	0.1624	0.134	0.1948
1,800	0.300	0.1156	0.257	0.1351	0.225	0.1542	0.200	0.1735	0.180	0.1927	0.150	0.2313
1,900	0.334	0.1360	0.287	0.1587	0.251	0.1814	0.223	0.2040	0.201	0.2267	0.167	0.2720
2,000	0.370	0.1586	0.317	0.1851	0.278	0.2115	0.247	0.2380	0.222	0.2644	0.185	0.3173
2,200	0.448	0.2111	0.384	0.2463	0.336	0.2815	0.299	0.3167	0.269	0.3519	0.224	0.4223
2,400	0.533	0.2741	0.457	0.3198	0.400	0.3455	0.356	0.4112	0.320	0.4569	0.267	0.5483
2,600	0.626	0.3485	0.537	0.4066	0.468	0.4647	0.417	0.5228	0.376	0.5809	0.313	0.6971
2,800	0.726	0.4353	0.622	0.5079	0.544	0.5804	0.484	0.6530	0.436	0.7255	0.363	0.8706
3,000	0.833	0.5354	0.714	0.6245	0.625	0.7140	0.556	0.8031	0.500	0.8923	0.417	1.0708
3,200	0.948	0.6498	0.813	0.7581	0.711	0.8664	0.632	0.9747	0.569	1.0830	0.474	1.2996
3,400	1.070	0.7794	0.917	0.9093	0.827	1.0475	0.714	1.1690	0.642	1.2990	0.535	1.5588
3,600	1.200	0.9252	1.029	1.0800	0.900	1.2335	0.800	1.4078	0.720	1.5420	0.600	1.8504
3,800	1.337	1.0871	1.146	1.2695	1.003	1.4508	0.891	1.6342	0.802	1.8135	0.669	2.1742
4,000	1.481	1.2691	1.270	1.4807	1.111	1.6922	0.988	1.9037	0.889	2.1152	0.741	2.5382
4,200	1.633	1.4692	1.400	1.7140	1.225	1.9589	1.089	2.2037	0.980	2.4486	0.817	2.9383
4,400	1.784	1.6892	1.537	1.9707	1.344	2.2522	1.189	2.5338	1.071	2.8153	0.892	3.3784
4,800	2.133	2.1930	1.829	2.5585	1.600	2.9241	1.422	3.2896	1.280	3.6551	1.067	4.3861
5,200	2.504	2.7852	2.146	3.2530	1.871	3.7177	1.670	4.1824	1.502	4.6471	1.252	5.5765
5,600	2.904	3.4825	2.489	4.0629	2.178	4.6433	1.936	5.2237	1.742	5.8041	1.452	6.9649
6,000	3.333	4.2833	2.857	4.9959	2.500	5.7110	2.222	6.4249	2.000	7.1388	1.667	8.5666

EXTENSIONS AND IMPROVEMENTS to the Kaministiquia Power Co.'s plant, Fort William, Ont., which will mean an outlay of approximately $1,000,000, will be commenced in the near future, according to R. S. Kelsch, consulting engineer for Hosmer, Holt and Thompson, of Montreal, principal owners of the plant. After a short inspection, Mr. Kelsch said preliminary surveys would be made at once. It is the intention to install a third big aqueduct from the intake pipe to the power house, a distance of a little over a mile.

PLANS AND SPECIFICATIONS for the new power house to be erected on Austin (Tex.) College campus, Sherman, Tex., have been accepted and work will be commenced as soon as the contract can be let. The contract for the new administration building will also be let immediately and work commenced as soon as possible. These buildings are to take the places of those burned early in the fall. Besides these buildings, citizens of Sherman have agreed to build Sherman Hall at a cost of $50,000, having already raised the money for this purpose.

WISDOM, MONT., the metropolis of the Big Hole country, is to have electric lights and electric power. Work was started recently on a road to Steel Creek, 6 miles away, and within a short time the plant itself will be built. It is expected to be completed, with lights in Wisdom, by Oct. 1.

The location is an ideal one. This creek has a fall of 300 ft. in a distance of 200 yd., and the amount of power that can be generated is practically unlimited. Although there is a natural lake at this point, a reservoir will be built for further water storage.

WITH THE APPROVAL of a riparian grant for about 850 ft. frontage along the Delaware River, the Public Service Electric Co. is ready to proceed in earnest with the construction of a large power station in Burlington, N. J. The project has been under way ever since the company took over the business of the Burlington Electric Light and Power Co., in 1911, but difficulties in the way of securing a proper site have retarded its progress. Because of the ultimate size and capacity of the station it was essential that the location should afford both water and rail facilities.

The plans adopted call for the construction of a station that will ultimately have a capacity of 50,000 kw. This will make it one of the largest in the State at that figure, but if for any reason greater capacity should be desired the ground room and general layout of the building would admit of further additions that would bring the total capacity to 75,000 kw. At the present time, however, the plans do not contemplate a station of any such proportions, there being no call for such a stupendous amount of energy in that section of the State.

It is intended to erect a building 100 by 200 ft. in dimensions. This will include a switchboard room, a boiler room for 6 boilers of 600-hp. capacity each and a generating room which at the outset will have equipment of 7500 kw. capacity. As the demands on the station grow to the extent that enlargement will be necessary, the building will be added to until it reaches the 50,000-kw. stage by which time it will be about 200 by 272 ft. in size and have 4 stacks each about 14 ft. in diameter at the base and 225 ft. high.

It can be readily understood from the size of the plant that it is intended not for Burlington alone but for a section of the State reaching practically to Trenton on the north and Camden on the south. It is even intended that the new plant shall supplement the Trenton and Camden plants and in cases of emergencies temporarily do part or all of their work. The present practically obsolete Burlington plant will be abandoned and in time the work of the Bordentown, Riverside and Mt. Holly plants will be taken over by the new station. It is expected that the new plant will be in actual operation early in the spring of 1914.

BOOKS AND CATALOGS

CHEMICAL ARITHMETIC AND CALCULATION OF FURNACE CHARGES, by Regis Chauvenet, 6 by 9 in., 300 pages, price $4. Starting with a page devoted to some fundamental laws of chemistry, then a few definitions which have been more or less confused, the author discussed the metric system of weights and measures as applied in chemical calculation and goes directly into the solution of chemical problems involving a knowledge of chemical elements and compounds, their combining and molecular weights, volumes, etc. Such problems consist of determining the relative weights of constituents entering into compounds, deduction of analysis from formula and the reverse, computation of gas volumes, calculation of analysis, assay weights and calculations, volumetric analysis, etc. Numerous exercise problems are given with their answers, followed by a number of tables dealing with chemical elements and compounds. Part II is devoted entirely to the calculation of furnace charges by which is meant the adjustment by computation of fluxes to the ore in a smelting furnace, so as to secure, so far as calculation goes, the formation of a slag of required composition. The book presumes a working knowledge of chemistry on the part of the reader and will serve as a text book as well as a handy reference for those engaged in chemical engineering or assay work.

WHAT USERS SAY ABOUT IT is the foreword on the cover of an interesting booklet issued by the United States Graphite Co., of Saginaw, Mich., in which letters from those who have had experience with Mexican boiler graphite are arranged alphabetically according to states, then cities or towns, and an index to all of the letters according to class of plant from which they come, is given at the end of the volume. The testimony as to the effectiveness of this graphite, which is of amorphous form, is so complete as to leave no question of the results that have been obtained. In the first part of the book, reasons are given for the action of this form of graphite in cleaning off the scale and keeping boilers free from scale, and also full directions are given how to use the graphite, and suggestions in regard to special conditions and the care of boilers.

THE WESTERN KIELEY STEAM SPECIALTY CO., located at 116-122 West Illinois St., Chicago, announce they have just received from the press a 96-page catalog illustrating and describing their various steam, air and water regulating appliances. Last year the company built a large 7-story fire proof factory and warehouse at the above address equipping it with modern and special machinery to meet their requirements. In addition to manufacturing the Western Kieley goods they have added the Boylston line, all of which are shown in the new catalog, a copy of which will be sent upon request, mentioning Practical Engineer.

SMALL MOTORS, a pamphlet published monthly by the Industrial and Power Department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has just been received. Number Sixteen deals with electric washing machines and some of the features of Westinghouse motors.

LATEST ISSUE of The Bearing was recently received from Albany Lubricating Co., 708-710 Washington, St., New York City.

McEWEN BROS., of Wellsville, N. Y., has recently issued Bulletin No. 1 on pumps for steam turbine drive and Bulletin No. 2 on blowers for steam turbine drive, forced draft and similar service.

A PAMPHLET ENTITLED, "The Insulation of Underground Steam Lines" has just been published by Armstrong Cork Co., of Pittsburgh, Pa. It contains some interesting data on the heat loss from bare pipe and also through Nonpareil high pressure covering.

"STEAM SEPARATORS" is the subject of Section A of the catalog of Cochrane separators just issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa. This section lists the live steam separators for all ordinary boiler pressures, in the horizontal, vertical and angle forms. The introduction contains various suggestions on the best manner of using steam separators, and on the benefits thereby obtained through the protection afforded the engines against large masses of water coming over from the boiler or from pockets in the steam line, and also through the economy resulting from the use of dry steam. It is stated that each one per cent of moisture increases the water rate of the engine by 2 per cent; also, that where efficient steam separators are employed, engines can be operated upon half the amount of oil usually required with wet steam and with less friction and wear of the valves, piston and cylinders. The separator also serves as a catch-all for articles left in the steam pipe, such as nuts, cold chisels, wrenches, pieces of packing, grit, scale, etc. In the case of turbines, equal benefits are claimed, also increased life of turbine blades and maintenance of high efficiency.

Copies will be supplied to those interested, on request.

TRADE NOTES

ON AUGUST 1 the National Tube Co., of Pittsburgh, entered the electrical conduit field, the National Metal Moulding Co. and Safety Armorite Conduit Co., of the same city, manufacturing and selling the conduit as agents of the National Tube Co.

UNPRECEDENTED GROWTH of the business of the Coppus Engineering & Equipment Co., of Worcester, Mass., has compelled its removal to new shops. This company which manufactures the Coppus Noiseless Turbine Blower used principally for undergrate draft is still in Worcester but now located at 166 Union Street where the equipment is more than double that in the old shop and there is almost unlimited room for expansion.

EAST PITTSBURGH was deserted on Saturday, July 12, when the 27th annual outing of the Westinghouse Electric & Manufacturing Co. was held. The outing was in Idlewild park, near Digonier, Pa. About 10,000 persons attended and enjoyed immensely the events of the day. Ten trains of 12 cars each were used to convey the picnickers to the park, while several others went in automobiles and other conveyances. The principal events were on the athletic program. A ball game was held between teams of the company, the winners securing handsome prizes donated by the company. A holiday was declared, as usual, and everyone connected with the company, either in offices or shops, was invited to participate. Children of the employes also attended,

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POSITION WANTED—As Electrical Engineer; at present in charge of large electrical plant in New York. 12 years' technical and practical experience. Strictly sober and industrious. Address William MacInally, Pleasantville, N. Y. 8-15-1

POSITION WANTED—As Engineer in small plant, or assistant in a large plant, by man of 28 yrs. No bad habits, 3 yrs. machinist experience; understands A. & D. current; holds local engineers license. C. H. Freeman, 57 North St., Elgin, Ill. 7-1-2

Wanted

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